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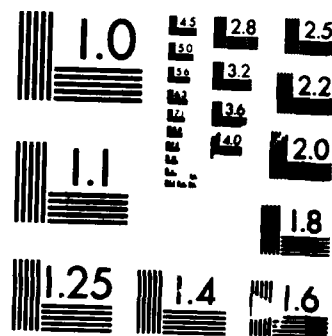
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**A RAND NOTE**

**Individual Ready Reserve Skill Retention  
and Refresher Training Options**

**Susan Bodilly, Judith Fernandez,  
Jackie Kimbrough, Susanna Purnell**

**December 1986**

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This Note explores the determinants of key attributes of a training program for Individual Ready Reserve (IRR) members. It examines relationships among time since separation, skill retention, task characteristics, and different forms of training. It analyzes the relevant academic and military literature on skill retention and training needs, and proposes a research agenda and a decision framework designed to provide information and structure for IRR training program decisions. The authors recommend that decision frameworks for IRR training take into account the usefulness of other mobilization assets, the time and resources available at mobilization for IRR training, the skills that are critical to mobilization, and cost concerns. This decision framework must be supported by further information on skill retention in the IRR, training needs of the IRR, costs of refresher training, and the willingness of the IRR to train.

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# A RAND NOTE

N-2535-RA

## Individual Ready Reserve Skill Retention and Refresher Training Options

Susan Bodilly, Judith Fernandez,  
Jackie Kimbrough, Susanna Purnell

December 1986

Prepared for  
The Office of the Assistant Secretary of  
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# RAND

## PREFACE

This report explores the determinants of key attributes of a training program for Individual Ready Reserve (IRR) members. It examines relationships among time since separation, skill retention, task characteristics, and different forms of training. It analyzes the relevant academic and military literature on skill retention and training needs, and proposes a research agenda and a decision framework designed to provide information and structure for IRR training program decisions. The research was sponsored by the Office of the Assistant Secretary of Defense (Reserve Affairs) in RAND's National Defense Research Institute, a Federally Funded Research and Development Center supported by the Office of the Secretary of Defense. It was conducted by the Individual Ready Reserve Training Needs and Options project, part of RAND's Defense Manpower Research Center.

Those agencies and individuals concerned with IRR training, skill retention, and refresher training in the armed services, and with the readiness of the armed services, should find this Note of interest.

The attention now being paid to the IRR is causing many changes in the services' IRR programs. This research, performed in late 1985, reflects the service programs at that time.

## SUMMARY

In the past few years the Congress, the Office of the Secretary of Defense (OSD), and the military services have become concerned about the readiness of the Individual Ready Reserve (IRR). Most members of the IRR are reservists who have finished an active-duty military service contract, but who have time remaining in their military service obligation. Any large mobilization of the armed forces will require the call-up of the IRR, yet few IRR members currently attend training. Concern about readiness, therefore, extends to the IRR. The services are uncertain if IRR members retain their military skills over the average four to six year period that they serve in the IRR, and do not know what kind of training program would be most appropriate for refreshing decayed skills. The Office of the Secretary of Defense recently required the services to determine IRR skill retention and to develop refresher training options.

This Note provides guidance regarding the information needed by the services to develop an IRR refresher training program for enlisted personnel. The Note provides: a decision framework for deciding whether or not to refresh individuals in any particular specialty; a review of the literature on military skill retention; a discussion of refresher training costs; and a brief look at the motivation of the average IRR member to attend refresher training. Throughout, it is not our intention to provide definitive proposals concerning the details of a training program, or even a handbook for determining such details. The state of knowledge concerning IRR training needs and objectives is not sufficient for either. Rather, we explore the information that is available, identify unmet information needs, and suggest ways in which technical information should be combined with broad policy choices to design an IRR refresher training program.

In this study, we focus on the enlisted IRR, especially that of the Army and Marine Corps, for the following reasons: (1) the enlisted IRR has been somewhat neglected by past training policies; (2) the Army constitutes over 60 percent of the IRR; and (3) the Army and Marine



Corps are particularly dependent on the IRR during mobilization and have ongoing refresher training programs.

From our research we conclude that the decision of whether to refresh an IRR member's skills must consider the role that the member will play during mobilization and whether another asset is available to fill that role. Tradeoffs must be made between time and effectiveness gained at mobilization and the costs of IRR refresher training prior to mobilization. These tradeoffs are properly made with knowledge on IRR skill deterioration, training options and their costs, and IRR training motivation.

It may become apparent, upon closer examination, that for some specialties (and some tasks) it is simply not practical to rely on the IRR to provide the skills needed at mobilization. These will be specialties where: (a) there are too few members in the IRR to meet mobilization needs, (b) skills decay too rapidly to maintain IRR proficiency and cannot be refreshed quickly, or (c) refresher training is too costly to make skill maintenance reasonable. For these skills, it may be necessary to modify mobilization planning to reduce reliance on the IRR.

For occupational areas and types of tasks where mobilization planning continues to rely on the IRR, several refresher training options exist:

- Do not refresh if the skill decays slowly or not at all.
- Refresh periodically if the skill is needed immediately at mobilization.
- Refresh at mobilization if time is available then.
- Combinations of the above.

The decision of which option to choose for any particular specialty (or task within a specialty) should depend on technical factors such as the rate of skill decay, the time needed to refresh a skill, and the costs of refreshing, as well as on more basic issues such as the minimum acceptable level of proficiency.

If the option of periodic refresher training is chosen, a further decision must then be made as to length, frequency, and type of training. Decisions on these parameters of a training program will depend on factors such as the initial skill level of IRR personnel, rates of skill decay, and characteristics of the skills to be refreshed.

We found from the literature review that, although research on skill retention provides many interesting concepts and facts, little is directly applicable to the IRR. The studies reviewed did not test the IRR and the subjects that were tested had characteristics quite different from the IRR. In particular, the retention interval in the tests was short--less than a year--while IRR members need to retain skills over periods up to six years. Nevertheless, some broad conclusions can be drawn from the literature. In general, the retention of procedural tasks, the sequencing of tasks, and the ability to perform a task in a required time period deteriorate rather quickly. Continuous motor skills, performance accuracy, and tasks supported with aids deteriorate less rapidly. An individual's post-training score on a performance test, combined with the length of the retention interval, is the best predictor of skill retention.

Controlled experiments and surveys can provide some of the needed information on IRR members. We recommend that the services begin testing IRR members upon transfer from active duty and after each refresher training opportunity attended thereafter. This information should become a part of the member's service record. The IRR member may also be tested after each muster and asked to give details of his civilian experiences. Such data will provide a baseline for determining IRR skill decay. Small-scale experiments also can be run on targeted skill areas to determine specific skill retention and the most effective training options.

Like skill retention, our research shows that the services lack complete information about relevant costs of possible IRR refresher training options. Although the services maintain enough information to program IRR gross training budgets, they do not have sufficient detailed cost information to make important choices between training options. The specific cost information that does exist is scattered among several

commands within each service. Without more and better-coordinated information, IRR refresher training decisions will be taken with insufficient knowledge of their costs. In the Note we suggest ways this lack of information may be remedied. Especially important will be improved ways of reporting the data that are now collected.

The services also know little about the motivation of IRR members to attend training--only a small percent now voluntarily refresh their skills. For an IRR refresher training program to have any significant effect on readiness at mobilization, marked increases in participation are necessary. Further information on motivations, responses to incentives, and responses to the training program is needed to set up a program that will ensure the participation rates desired. To collect the information needed we suggest a series of surveys questioning IRR members on background, employment, employer's attitude toward employee training absences, training satisfaction, monetary incentives, and so forth. These surveys could be easily administered during annual IRR musters.

All of the above-mentioned information requirements, when satisfied, could be used to set up a well-structured IRR training program and contribute to a smooth mobilization. A well-run program may increase participation in voluntary refresher training, as well as the availability of skilled personnel at mobilization.

The use of yearly musters, which the services are currently developing, provides an excellent opportunity to determine skill deterioration, refreshing needs, and participation rates. The Army, in particular, has adopted the muster and has begun collection of relevant data on its IRR members to perform analyses that will enable effective and efficient IRR refresher training decisions.

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## I. INTRODUCTION

One of the nation's mobilization assets is the Individual Ready Reserve (IRR). Most IRR members have completed their active duty contract, but still have time remaining in the eight-year military service obligation that is a part of all such contracts. IRR members do not belong to or train with units. Rather, they represent a pool of pretrained, militarily experienced individuals that can be called to active duty during national emergencies. Currently, service plans for mobilization expect the IRR to immediately fill vacancies in existing active or Selected Reserve units, and perhaps later to replace casualties. Presumably IRR personnel would fulfill this role better than the primary alternative--new recruits--regardless of IRR training programs, because all IRR personnel have some prior experience on active military duty. However, the readiness at mobilization of the U.S. armed forces will be greater, the better the IRR maintains its skills in peacetime. With less than 5 percent of IRR enlisted personnel now receiving any form of refresher training, there is presumably much room for improvement.

The Congress, Office of the Secretary of Defense (OSD), and the services, concerned over readiness and mobilization issues, have turned their attention to IRR skill retention for two primary reasons. First, the services provide only small allocations of training funds to the IRR; thus, the IRR receives little training to maintain its skills for mobilization. Second, in an effort to increase the number of IRR members available at mobilization, the Congress extended the military service obligation to eight years beginning in 1984; previously the obligation had been for six years. Thus, in the future many IRR members may not have used their military skills for more than four years prior to a mobilization.

Responding to the concern over the readiness of the IRR, in 1985 and again in 1986 OSD requested in the *Defense Guidance* that the services determine IRR skill retention and institute any necessary refresher training programs. Concurrently, OSD asked RAND to study the issue of IRR refresher training needs and options.

Our research addresses the questions of whether IRR enlisted personnel maintain their skills without systematic practice and what kind of refresher training program would increase their skill retention. We collected information about the IRR and its refresher training programs from interviews with the reserve components of the services, IRR program managers, statistical data provided by the managers, and standard military personnel references. We learned about the IRR role in mobilization from the offices that are responsible for mobilization issues in the services and at OSD. Information on skill retention--in general, in the military, and in the IRR--was gathered from the above interviews and from a thorough search of the published literature on skill retention and refresher training needs.

In the past the services focused their limited IRR management resources on officers. Enlisted personnel, who account for over 85 percent of the IRR, received little attention. This research, in contrast, addresses skill retention issues for the enlisted force. We concentrate on Army and Marine Corps programs, because these two services depend more heavily on the IRR for mobilization and have ongoing programs to actively manage the members.

While many other important issues surround IRR management--for example, ability to contact IRR members at mobilization, rates and physical condition of IRR members who report for exercises and mobilization, retention of IRR members past mandatory service length, and usefulness of annual musters--this research concentrates on predicting enlisted skill retention and choosing among refresher training options. We propose a framework for considering which, if any, specialties to refresh in the IRR and which tasks to refresh within a specialty. The major assumption of this decision framework is that the IRR cannot be managed separately from the other mobilization assets. This framework led us to focus on three areas of inquiry: the determinants of IRR skill retention and training, costs of training, and the ability to motivate the IRR members to attend training (assuming training is not made mandatory). In all three areas we found little information specific to the IRR. Therefore, this Note sets out the research agendas necessary to determine a viable IRR refresher training program.



The remainder of this document has six major sections. The first describes the IRR and its refresher training programs. The second presents a decision framework for considering IRR refresher training needs, describes broad options for improving IRR skill retention, and identifies in general terms the information requirements for a training program. The third section analyzes the literature on skill retention to determine what is known, and whether current knowledge will enable the services to adequately predict IRR refresher training needs. The fourth section analyzes known IRR training costs, the fifth briefly considers motivating IRR members to attend training. Suggested research agendas for each subject are detailed in the final paragraphs of each section. Conclusions and overall recommendations appear in the final section. An appendix contains details of the literature review.

## II. BACKGROUND

The Ready Reserve consists of two major groups: the Selected Reserve (SR) and the Individual Ready Reserve (IRR). Members of the SR are assigned to units, train in their unit on a periodic basis, have unit equipment in place, and organize similarly to the active duty components. (A subgroup of the Selected Reserve is the Individual Mobilization Augmentee or IMA--a reservist who is assigned to and drills with an active duty unit.) It is this segment of the Ready Reserve that most frequently comes to mind when "the reserves" are discussed. The less-well-known IRR is a group of once-trained individuals, not organized into units, whose continued training is voluntary and irregular. The great majority of IRR members have finished their active or SR duty contract, but still have time remaining in their military service obligation. A minority, almost all officers, have remained in the IRR after their military service obligation expired. Legally, IRR members are available for call to active duty when the President declares an emergency or upon declaration of war. They also may be required to report to active duty for training for up to 30 days per year. To date, however, all training has been on a voluntary basis,<sup>1</sup> whereby IRR members perform drills, participate in correspondence courses, and provide support to units.

There are no special requirements for becoming an IRR member, and joining is seldom a matter of positive choice. Rather, membership is automatic and required upon fulfillment of the active duty or SR contract. Any time remaining in the obligation to serve is automatically transferred to the IRR. In the past, however, some individuals have voluntarily transferred to the IRR. In the early Reserve era, it was common for individuals to transfer to the IRR during this time, to continue to train in a reserve unit or to work for the Government. These individuals were usually those who had completed their active duty or SR obligation and were not yet eligible for discharge. They were usually those who had completed their active duty or SR obligation and were not yet eligible for discharge.

<sup>1</sup> Current law (10 USC 2404) requires that IRR members be available for training. However, the law also provides that training be voluntary. The law also provides that training be voluntary. The law also provides that training be voluntary.

obligation. Thus there is no guarantee that the IRR pool will match the wartime requirements for personnel. For some occupational areas there may be too few IRR members to fill the shortfall between wartime requirements and peacetime manning. This shortfall will be met by retired reserves, draftees, or volunteers. In other occupational areas, more IRR members may exist than are needed to fill the shortfall.

In addition, training of IRR members is not linked to mobilization needs. Training is voluntary, although when an IRR member attends a training exercise he or she is compensated as any other reservist on active duty, with pay and allowances, travel, per diem, and retirement points.

The mobilization of the U.S. armed forces depends on the IRR. In peacetime, the active and SR units man below the level needed for wartime mobilization. Upon mobilization, the services expect to call the IRR to duty to fill out existing active and SR units to their full-time military strength. Without the IRR, the services would likely either use inexperienced new recruits or dismantle low priority SR units and use the members as fillers for undermanned active units and high priority SR units.<sup>2</sup> The latter disrupts the integrity of existing units and wastes the valuable time and effort placed in developing unit cohesion and responsiveness.

## IRR COMPOSITION

The IRR contains both officers and enlisted personnel. Table 1 shows that as of March 1985 the enlisted account for about 85 percent of the IRR force and include approximately 384,000 soldiers.

The IRR is managed at the service level and so has several components.<sup>3</sup> Approximately 63 percent are in the Army, 14 percent are in the Navy, 11 percent are in the Marines, and 9 percent are in the Air Force.

<sup>2</sup>Air Force plans call for use of the retired reserve instead of dismantling SR units.

<sup>3</sup>The National Guard and Coast Guard IRR components make up less than 5 percent of the total and are excluded from the table.

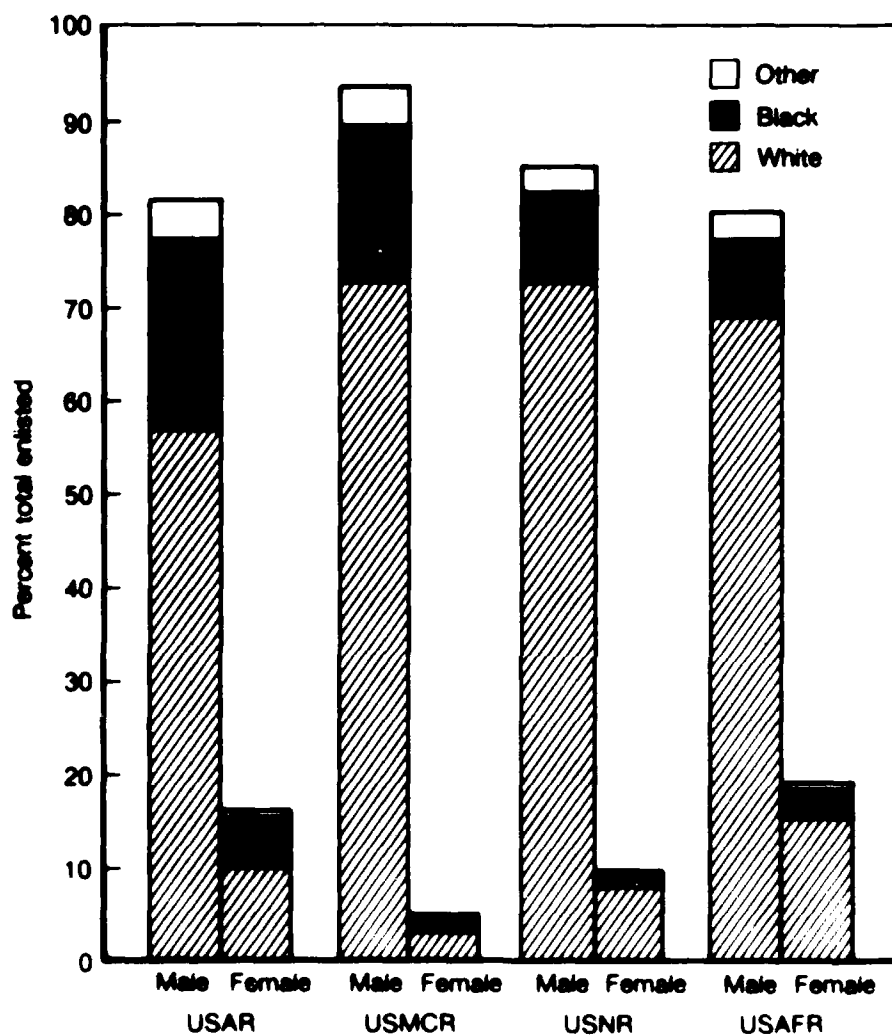
Table 1  
IRR COMPOSITION

	Army	Navy	Marines	Air Force	Total
Total IRR	286,337	72,241	46,382	41,861	446,821
Officers	44,358	16,834	3,326	7,940	72,458
Enlisted	241,979	55,407	43,056	33,921	374,363
Enlisted Average grade	3.2	3.8	3.7	4.0	3.5
Percent at skill level 1	85	69	80	81	81

Table 1 also shows the average grade and skill level of IRR members. Most are at Army skill level one or its equivalent. The average pay-grade is between E3 and E4, with the Army having the lowest average grade. The IRR is primarily made up of white males with the majority located in the eastern United States, as shown in Figs. 1 and 2.

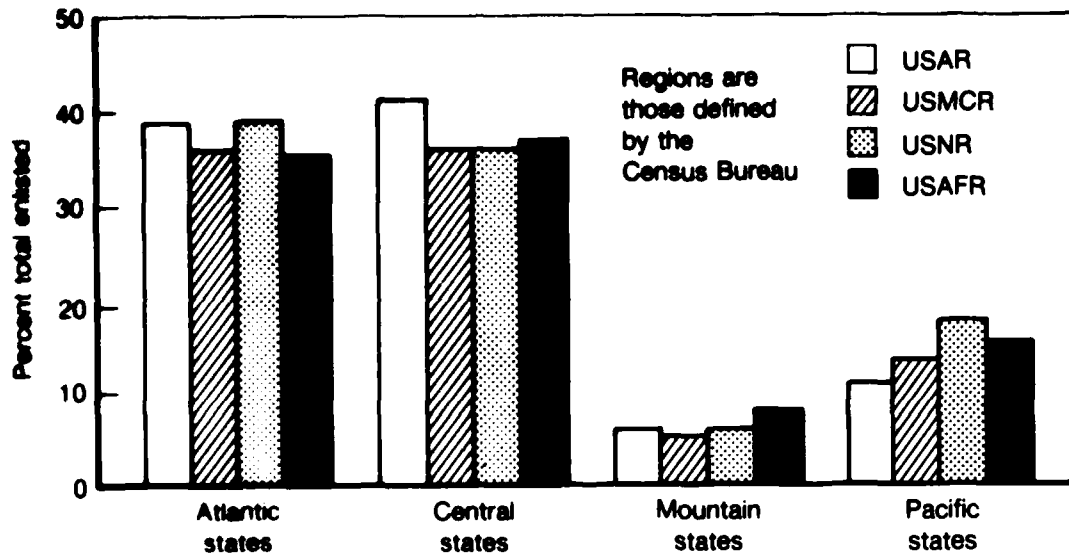
Figure 3 shows selected military occupations of the IRR. The Army and Marine Corps IRR largely qualify for an occupation, whereas the Navy has the largest percentage of non-occupationally qualified personnel. The Air Force has the smallest. Among IRR members who are occupationally qualified, most are found in the infantry, maintenance, and support areas. The Air Force appears to have the most disparate group of occupations in the IRR.

Figures 4 and 5 show that the Army and Marine Corps IRR are overwhelmingly in the 20 to 24 year age bracket. The majority are high school graduates, but very few have attended college. The Army has a large proportion of non-high school graduates (15 percent).



Source Assistant Secretary of Defense (IML) Official Guard and Reserve Manpower Strengths and Statistics March 1985 Report A6

Fig. 1 Race and sex of enlisted IRR



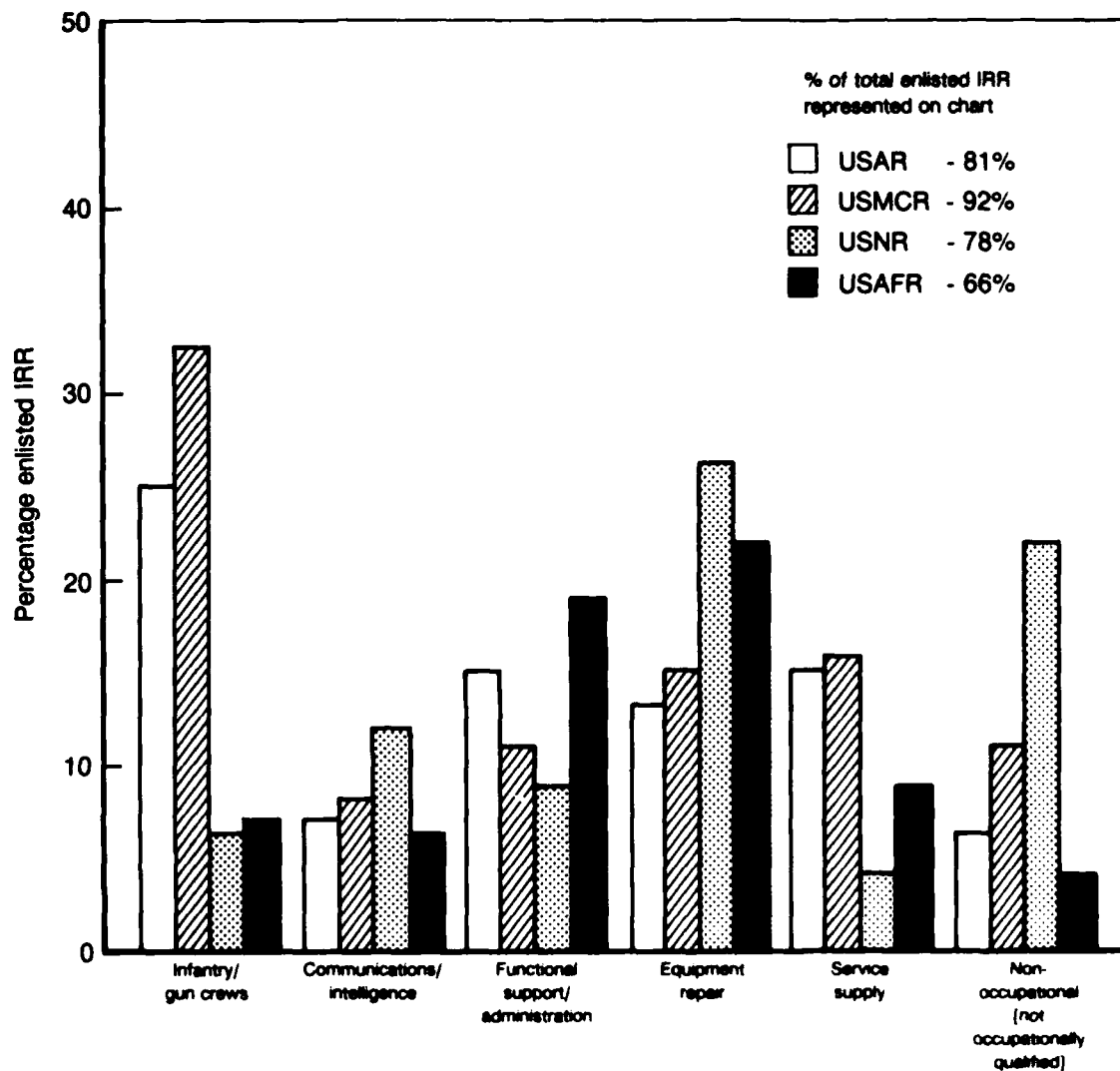
Note: Total of columns for services may not add to 100% due to discrepancies in reporting.  
 Source: Assistant Secretary of Defense (MIL), Official Guard and Reserve Manpower Strengths and Statistics, March 1985, Report A6

Fig. 2—Geographic region of enlisted IRR

## TRAINING PROGRAMS

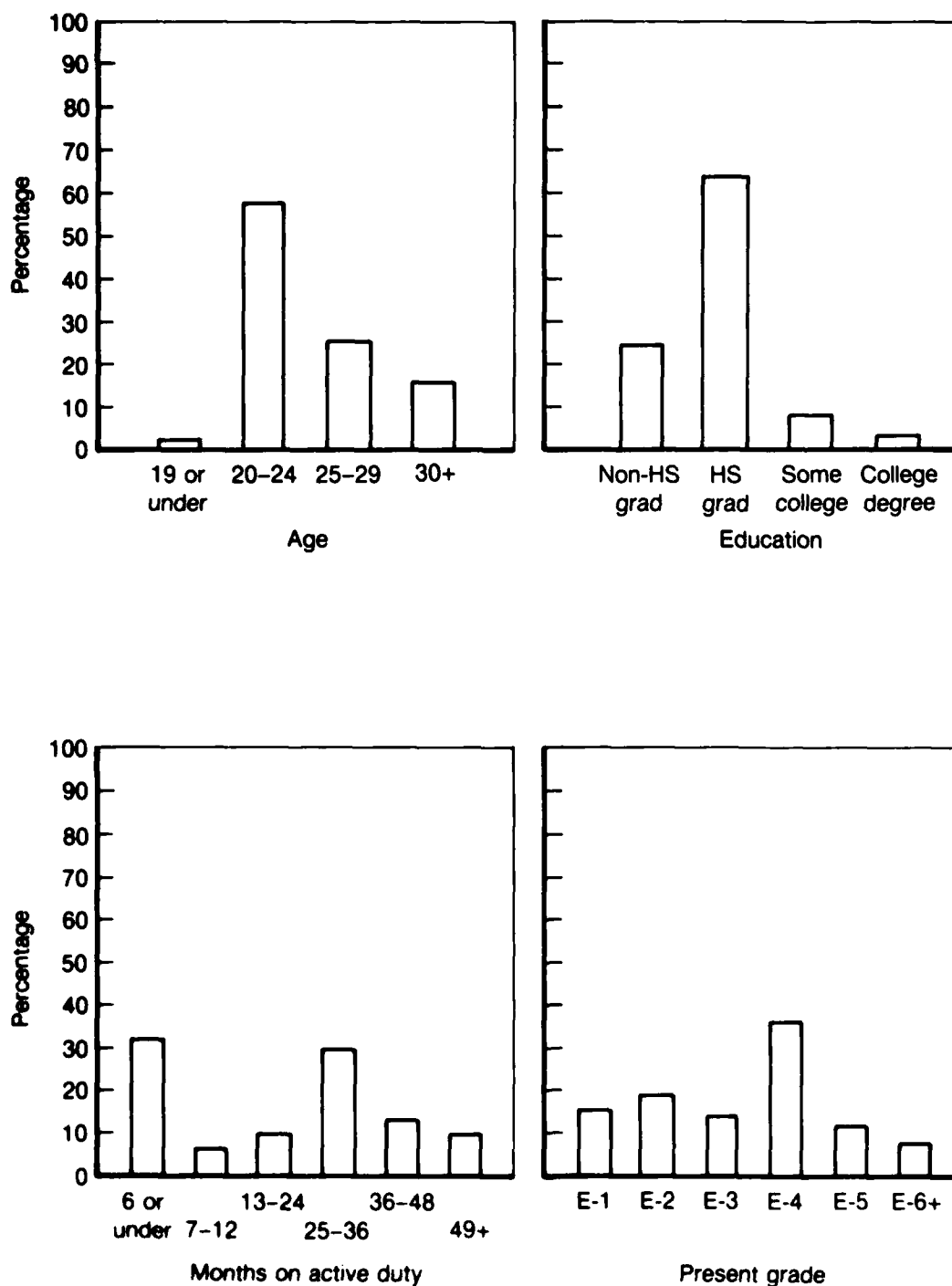
The Air Force does not currently train its IRR. Although the Army, Navy, and Marines train more actively, the percentage of enlisted IRR trained is very low—less than five percent train each year. However, the number of enlisted IRR members who train has been increasing in the past few years because of increased emphasis by the services. The enlisted IRR member may volunteer for the following training opportunities:

- *Intermediate training*—IRR members can train once annually with a program that lasts for a minimum of two weeks and a maximum of four. The IRR member works beside an active duty member and receives training. Refreshing his or her primary skills and knowledge. Skills that are refreshed, and knowledge that is new.
- *Advanced training*—IRR members can apply for formal school courses that are available to active duty members.



Source: Assistant Secretary of Defense (MIL). Official Guard and Reserve Manpower Strengths and Statistics, September 1984. Report A15

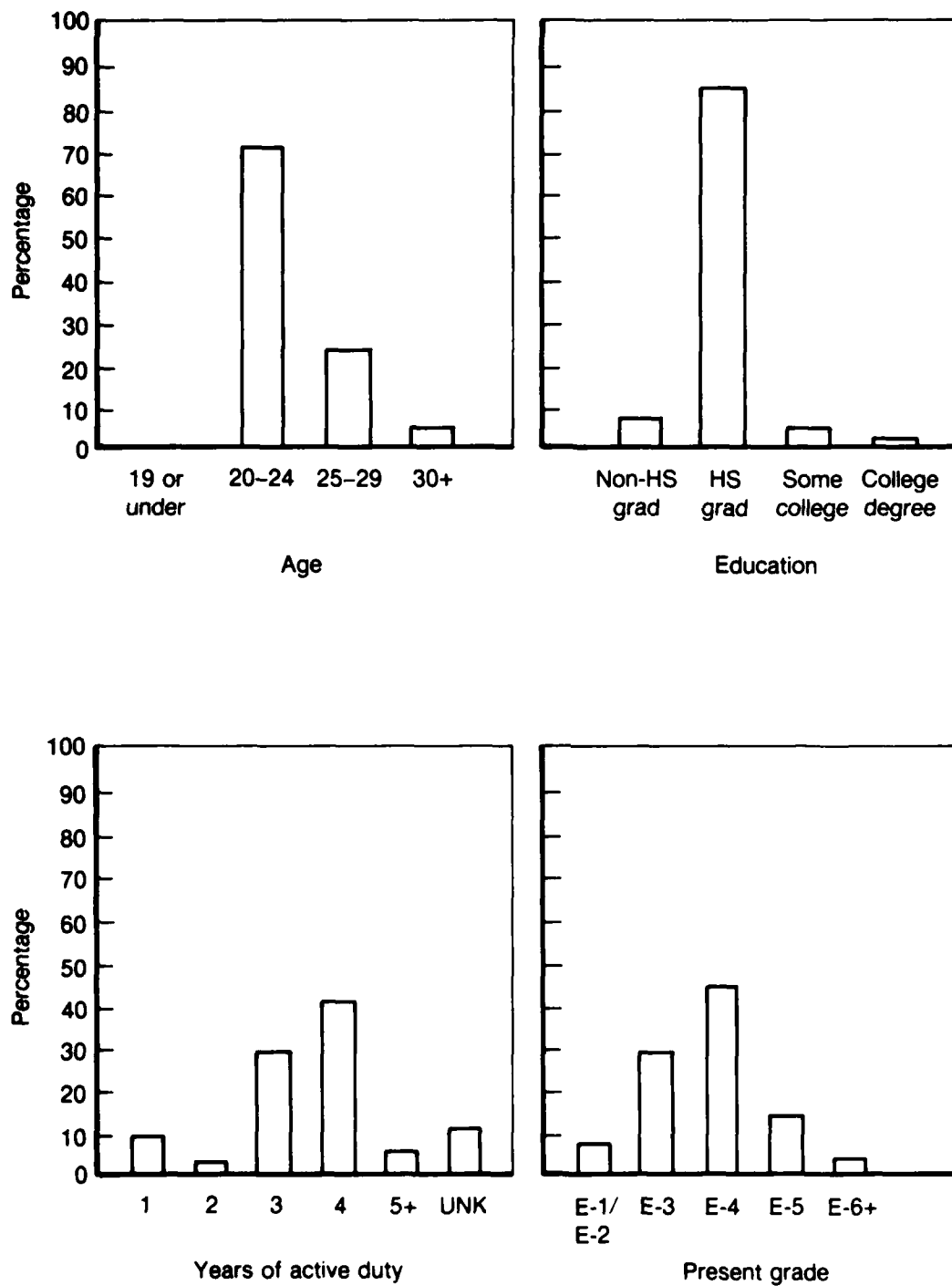
Fig. 3—Enlisted IRR by selected military occupations



Source: Statistics received from Army Reserve Personnel Center, Enlisted Management Division, August 1985

Fig. 4—U.S. Army IRR characteristics (FY 1985)  
(Percent in category)





Source: Statistics received from U.S. Marine Corps Reserve Support Center, August 1985.

Fig. 5—USMC IRR characteristics  
(FY 1985)

- *Exercise support.* Enlisted IRR can volunteer for temporary active duty status to support a unit. The job performed while on duty does not have to be in the primary occupation. Oftentimes units use IRR members during special exercises to fill out the unit to wartime capacity.

## CONCLUSIONS

This quick survey of the IRR leads to several generalizations. The IRR are predominantly young males in the early stages of a civilian career. They are not highly skilled, although most have spent between two and four years in the military. The Army and Marine Corps with their high concentrations in a few occupational categories may be able to focus on a few skills to determine a refresher training program. The Army with large numbers of personnel with less than six months of service and the Navy with large numbers not assigned a primary occupation may have to consider initial skill acquisition as well as refresher training or completely exclude some members from rapid mobilization. The latter option may be preferable, because some IRR personnel have been discharged from active duty for disciplinary reasons (especially in the Army), and so may not be good candidates for mobilization.

The concentration of the IRR in the east implies a geographic focus for on-site training. Finally, the current training programs involve few members. If more members of the IRR must refresh their skills for mobilization readiness, the present management program might have to be changed to encourage the participation desired.

Section III describes a decision framework--a systematic approach to choices among options available to the services to improve IRR readiness.

### III. DECISION FRAMEWORK

How and when the IRR will be used at mobilization to a large extent dictates what an effective refresher training program should accomplish. In an ideal scenario, at mobilization notice will be sent to IRR members to report. The IRR members will have maintained their individual skills and be ready to report immediately to a unit. At the unit they will need *brief* refamiliarization with equipment and practice with their individual skills. In addition, early placement in the unit may provide an opportunity for unit training and the building of unit cohesion. Within several days of mobilization, IRR personnel will fill out active and Selected Reserve units to their wartime requirements, providing pretrained, experienced manpower to them.

That is an ideal system. The existing system falls short of this ideal for many reasons, but we will concentrate on one. The system assumes that IRR members maintain their individual skills over time and will be ready to mobilize, needing only a short period of on-the-job training at their unit. If that assumption does not hold, and we will show in the next section that it does not, then the services may wish to establish a premobilization refresher training program.

In fact, the Army and Marines now assume that each IRR member will need to be tested at a mobilization center at the time of mobilization to determine if the enlisted member is ready for combat. If not, the enlistee will be sent to a training center to refresh skills. If ready, he will be sent to a unit. This approach requires that each Army and Marine IRR member report first to a mobilization center for testing and processing. Air Force plans are somewhat different--personnel may be required to report to the technical training center for their specialty rather than to a mobilization center--but the Air Force still expects to screen IRR members before assignment to the field. This extra step in the mobilization process, due entirely to uncertainty about IRR readiness, may significantly slow down mobilization.

Refresher training will both reduce the need for the extra screening step and improve the performance level of IRR members who are mobilized. Discussion with the services' IRR managers, however, has led us to conclude that a logical framework for making IRR training decisions is in a nascent stage. The services have only just begun to respond to increased congressional emphasis on the IRR and have not yet systematically and comprehensively considered refresher training decisions.<sup>1</sup>

The following paragraphs propose a logical framework for establishing an IRR refresher training program. They discuss the decisions that need to be made, and the information needed to make them sensibly. Some of the tradeoffs that might have to be made are highlighted. Our goal is both to delineate the context in which any refresher training program for the IRR will function, and to suggest key questions that must be answered before such a program is established.

In the discussion below, the decisions to be made are treated as being sequential. In fact they are frequently interdependent. In addition, although much of the discussion is couched in terms of choosing training programs based on the characteristics of the individual reservist's occupational specialty, it should be noted that (1) the preferred refresher training approach may vary for different tasks within a specialty and (2) it may not be desirable to refresh all individuals, or all tasks, within a particular specialty. These points are discussed separately below.

## MOBILIZATION PLANS

The first step in determining the scope and form of an IRR training program is to examine current mobilization plans. Information on how many IRR members, and in what specialties, will be needed at or shortly after mobilization can then be used to guide decisions on what

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<sup>1</sup>The Air Force is unique in having systematically considered the length of time after separation from active duty that an individual retains the ability to perform in his military occupation. The Air Force, however, has no current plans to refresher train IRR members if this interval expires before the end of the IRR member's military commitment.

specialties should be examined most carefully for training needs. The services have the means to perform this exercise--for example, the Army uses its MOBPOWER model to produce priority lists of IRR MOS needs based on mobilization scenarios.

For some specialties, it may be readily apparent that the IRR cannot fill mobilization needs--either because there are simply not enough members with earlier training and experience to fill the gap, or because the skills needed deteriorate rapidly or are quite difficult/expensive to maintain. For those specialties, the best option may well be to abandon all thought of refreshing the skills of IRR members, and rely on another asset at mobilization. The "other asset" might be an augmented active or SR presence in the skill or occupation, or it may be an arrangement that leads to lower U.S. mobilization requirements in the specialty--e.g., agreements with allies to provide the missing manpower, or measures that reduce the need for manpower (through better casualty care or long-term changes in the equipment/labor ratio, for example).

The factors influencing the choice of whether to rely on another asset at mobilization will be primarily (1) the number of members in the specialty compared to the number required by mobilization plans, (2) the rate of skill deterioration, (3) the time and cost requirements of refresher training, and (4) the existence of alternative ways to meet mobilization needs.

Specialties with enough members that they may realistically be expected, with refresher training, to fill the manpower shortages implied by mobilization plans are candidates for refresher training programs. In such programs, the cost of training, whether periodic or at mobilization, must be weighed against the benefits that will be gained at mobilization in terms of added readiness. Under current budget constraints it is likely that training resources available may not be sufficient for a comprehensive IRR refresher training program. Thus, it may be necessary for the services to allocate training funds to specific skill areas based on that skill's importance during mobilization. Important skills may be skills with the greatest shortfall at mobilization, skills needed soonest at mobilization, skills taking the longest to refresh, or skills without which the mobilization effort would be inhibited (bottleneck skills).

The target level of proficiency in the IRR also involves difficult choices. Refreshing to high skill levels costs more than minimum proficiency. With limited budgets, choices must be made as to whether to refresh all skills to a minimum level, or the most important skills to a higher level.

#### OPTIONS FOR ENSURING PRETRAINED MANPOWER

Once overall decisions are made on which specialties and skills to focus on, and what level of proficiency to aim for, there remain the questions of whether and how to refresh IRR skills. There are several basic options:

*Do not refresh.* Individuals may retain certain skills for long periods of time, especially if they use them in civilian jobs. Upon mobilization, time may be limited, but on-the-job refreshing of procedures could be adequately performed at the unit.

*Improve initial training.* Some skills may be retained longer with better initial training. This would have the added advantage that it may improve performance in the active and Selected Reserve as well.

*Continually refresh.* For skills not retained very long, the IRR could be refresher trained periodically. The extent of training would depend on skill retention by skill area, costs of refresher training, the mobilization role, and possibly by an individual's particular need.

*Train at mobilization.* For skill areas that can be quickly refreshed or are not needed until late in mobilization, refresher training may be postponed until mobilization begins.

In deciding among these options, a number of factors should be considered, most prominently the time available at mobilization and time available for annual training prior to mobilization.

To decide whether to train now versus at mobilization, it is useful to examine the requirements for skills at mobilization as compared with the time available to refresh then. Each skill will require a certain amount of time to refresh, whether at mobilization or periodically. In addition, a review of mobilization requirements will show that some skills in the IRR will be immediately demanded at mobilization. Others may not be demanded until quite late. Depending on the time available

at mobilization, some skills can be completely refreshed then, requiring no refresher training before mobilization. Other skills, those demanded immediately or in a timeframe less than the time determined necessary to refresh, will have to train periodically, or another option will have to be sought for filling the requirement.

The time required to refresh some skills may be too long to make periodic refresher training feasible. The services now generally plan for two weeks of voluntary active duty per year for IRR members, although federal law allows involuntary training for a period up to 30 days per year for all Ready Reservists in peacetime. Two weeks may be an optimistic estimate of the time IRR members will voluntarily train annually, but if we take this as a working hypothesis, then any training program must accomplish its goals in two weeks per year. If this period is too brief for effective refresher training, other options should be sought, including modifying mobilization plans to reduce the role of the IRR.<sup>2</sup>

The following rules are examples of the types of decisions and rules the services might develop to decide how a particular skill might be maintained. In fact, many skills could be refreshed using a combination of options.

- *Do not refresh* if: the time needed to refresh is near zero or the skill is maintained above the minimum required level for periods longer than six years.
- *Refresh periodically* if: the time to refresh takes less than two weeks.
- *Refresh at mobilization* if: the time needed for refresher training is greater than two weeks, but less than the amount of time available at mobilization.

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<sup>2</sup>Any modification of mobilization plans should, however, consider whether even a poorly trained IRR force may be preferable to the alternatives--which include relying on untrained new recruits.

## REFRESHER TRAINING OPTIONS

Once a specialty (or skill) has been selected as one in which the IRR should be periodically refreshed, the parameters of the refresher training program must be determined. Parameters of interest include

- How often to refresh the skill
- Length of each refresher training session
- Training technology (e.g., correspondence course, classroom instruction, video discs, field training)
- Location of training (a few central locations or many dispersed ones)

Different specialties--and different tasks within a specialty--will be best served by choices among these parameters, depending on interaction between (1) the initial skill level of the person in the specialty, (2) the relevant technical aspects of training (e.g., whether the skill can be refreshed by individual activity or some unit-level practice is required), and (3) policy decisions involving wider goals and constraints, such as the minimum level of proficiency expected of the IRR, or the value of a few highly trained IRR personnel relative to a larger number of less-well-trained reservists.

The full decision framework described above is summarized in Fig 6. This figure illustrates the decisions that need to be made and the factors that should influence each decision, as we have discussed them here.

## INDIVIDUALS, TASKS, AND SPECIALTIES

Up to this point, we have been discussing training programs primarily in relation to an occupational specialty. Individuals with disparate abilities, experience, and time since entry into service will be in the same specialty, and they will be expected to be competent at a number of distinct tasks. This means that any training program for the IRR must decide, in addition to what specialties, what tasks, which people and tasks on which to concentrate.



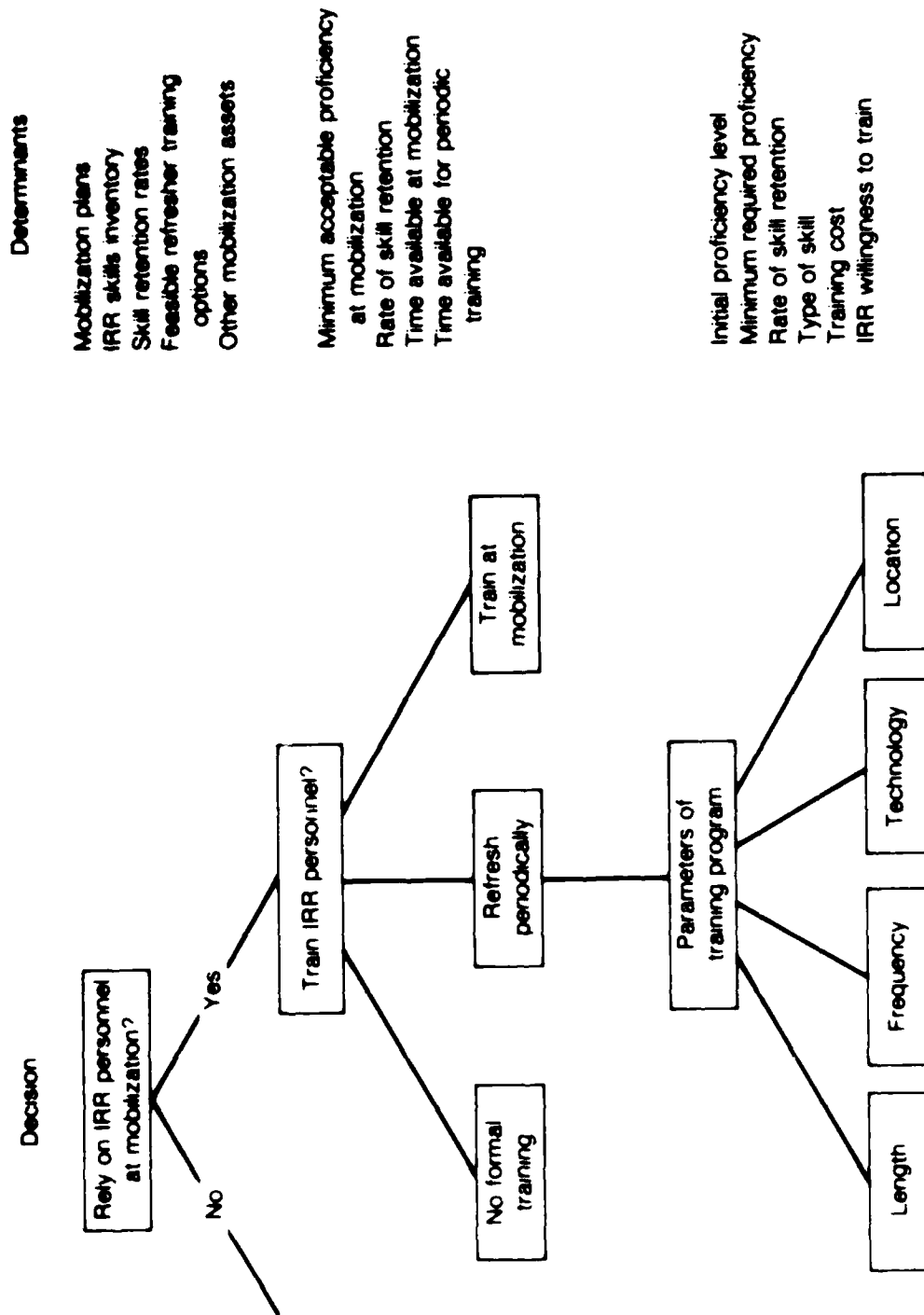


Fig 6 Decision framework

All IRR members in a specialty may be offered training, or only those who meet some minimum requirement in terms of active duty experience, skill level, or pay grade. Decisions on these aspects of training will depend on many of the factors already mentioned: how many of the IRR in the specialty are needed at mobilization, the minimum proficiency expected of each, and so forth. In addition, such issues as likely discipline problems from IRR members who left active duty early in their terms of enlistment may need to be considered. Most of the issues surrounding the decisions of which individuals to refresh are beyond the scope of this Note, but they are clearly relevant to the design of an IRR refresher training program.

Each occupational area may have important tasks that are largely performed only in peacetime, others that are largely performed in wartime. Or, the same tasks may be performed in wartime, but the time devoted to each may change dramatically. The cost of IRR training can be reduced by refreshing only wartime tasks. For example, a soldier in the motor pool may not be refreshed on motor pool tasks, but may need soldiering skills brushed up. Wartime tasks may be identified as combat tasks, tasks needed by the greatest number of people in wartime, and tasks which take up the most people's time during war.

More general policy considerations also enter the selection of tasks to be refreshed: an IRR training program will look very different depending on whether its primary goal is (1) to refresh basic soldiering skills, (2) to refresh occupation-specific skills, (3) to produce enlisted "leaders" who will be needed at mobilization, or (4) to retain military-experienced personnel, regardless of match between occupational area and mobilization needs. All four goals have implicitly or explicitly appeared in IRR training rationales, but they imply rather different choices of tasks or skills to be included in IRR training.

## INFORMATION NEEDS

The above paragraphs illustrate some of the types of decisions, decision rules, and trade-offs that the services should consider in determining a viable refresher training program for the IRR. Several information requirements are identified in the information system for the IRR.

skill deterioration and refreshing needs, (2) program costs, and (3) the time IRR members will devote to refresher training. The following sections discuss what is known about these information requirements, starting with skill retention and IRR training needs.

#### IV. SKILL RETENTION LITERATURE AND APPLICATION TO THE IRR

In this section we review two bodies of literature: academic literature on human learning and performance and military literature on the retention of soldiering skills. This section emphasizes the military literature; the appendix presents a broader view.

If the determinants of skill retention in the IRR (e.g., types of skills most likely to be retained, probable rate of retention, types of training which result in the greatest retention, and types of individuals most likely to remember certain skills/tasks) can be identified, then the services can efficiently and effectively target their training resources on those skills and those individuals most in need of refresher training. Unfortunately, the military has not empirically studied IRR skill retention.<sup>1</sup> Conclusions based on studies of active (or Selected Reserve) personnel may not be transferable to the IRR. This issue is discussed further below. First, however, we clarify a few basic terms.

##### DEFINITION OF TERMS

As used in this document, *abilities* refer to rather general, enduring attributes of an individual, and often exist without direct training (Fleishman, 1978). A specific ability may govern skills on a number of related tasks (Whiting, 1975). The term *skill* refers to the level of proficiency or performance on a specific task, and typically results from training (Fleishman, 1978). Skills are acquired or learned ways of using abilities (Prophet, 1976).<sup>2</sup>

<sup>1</sup>The Air Force has developed, and uses in its mobilization planning process, subjective "skill degradation factors" that indicate, for each Air Force Specialty Code, the period since separation from active duty during which an officer or enlisted person could perform in the specialty. See p. 33 below for further details.

<sup>2</sup>"Skill area" in the military usually refers specifically to a military job area, such as tank operator, cook, or communications operator.

Military researchers adopt a definition of a *task* as "whatever is called a task in the Soldier's Manual" (Rose, Allen, and Johnson, 1982). For example, two tasks might be replacing starters and generators on a tank engine, and loading/firing M203 grenade launchers. Steps are "...unitary, separable behaviors performed as part of a task, with distinct beginning and end points, as defined in the Soldier's Manual" (Rose et al., 1982). For example, the task of loading and firing the M203 has nine steps, starting with "lean the launcher" and ending with "aim and fire."

As used in this study, the term "skill retention" denotes the successful recall or recognition of a task some time after last performing that task. In terms of the IRK, the primary concern is whether members can perform common soldiering tasks, or tasks within their particular military occupation, at a satisfactory level at the time of mobilization--i.e., whether they have retained their skills at a level that allows immediate placement on the field. Precisely what this level is in terms of speed or accuracy of performance is, as mentioned in Sec. III, a question which the services will have to address before a training program can be chosen. For reviewing the literature, it is sufficient to note that both academic and military studies address the concept of skill retention using a comparison of performance before, during, and after a period of controlled activity--the retention interval. The measure of performance varies from study to study and task to task, but generally is based on some combination of speed, accuracy, and number of procedural steps correctly recalled.

The number of military tasks and the variance in skill among individuals make the development of predictive models of skill retention paramount. Both the academic and military research focus on ways to predict skill retention without testing each individual person for each individual skill. Two approaches are common: prediction by skill or task characteristics and prediction by individual characteristics.

In general, the literature indicates that, in the absence of practice or other reinforcement, skill deteriorates over time at a rate that is initially quite rapid. The rate of deterioration then decreases over the retention interval. Each skill is retained at a different

rate, as shown in Fig. 7 (Adams, 1967). In addition, each individual may retain skills differently. In general it has been found that individuals with greater initial learning, as indicated by a performance test, remain above some minimum skill standard longer, but that the *rate* of skill decay is about the same for all individuals (see Fig. 8).

## TASK CHARACTERISTICS AND SKILL RETENTION

According to the literature, task characteristics can be used to predict skill retention. Specification of these characteristics and their associated retention curves would allow IRR trainers to identify the types of tasks that IRR members retain and those that need refreshing.

In the early years of learning theory, academicians made distinctions among a number of types of skills: motor, cognitive, verbal, perceptual, etc. In more recent years, it has been acknowledged that such classifications are often arbitrary and incorrect. In fact, most soldiering tasks involve motor skills, are verbally and cognitively mediated, and frequently involve perceptual components (Fleishman, 1982).

Academic and military studies have consistently found that performance of tasks involving procedural skills deteriorate much more rapidly than those employing continuous or control skills and that procedure skills cannot be maintained without practice. Continuous skills involve the repetition of a movement pattern with no discernible beginning or end. Visual tracking of aircraft is a prime example. Procedural tasks consist of a series of short discrete responses, which typically have a distinct beginning and end. Examples are the loading of missiles or donning of gas masks.

Hypotheses regarding the differences in retention of procedural and continuous tasks include the notions that (a) the verbal-cognitive nature of procedural tasks makes them easier to forget and (b) since it is unclear what constitutes an individual trial in a continuous response, there may be constant practice and, hence, overlearning (Adams, 1967; Naylor and Briggs, 1961).

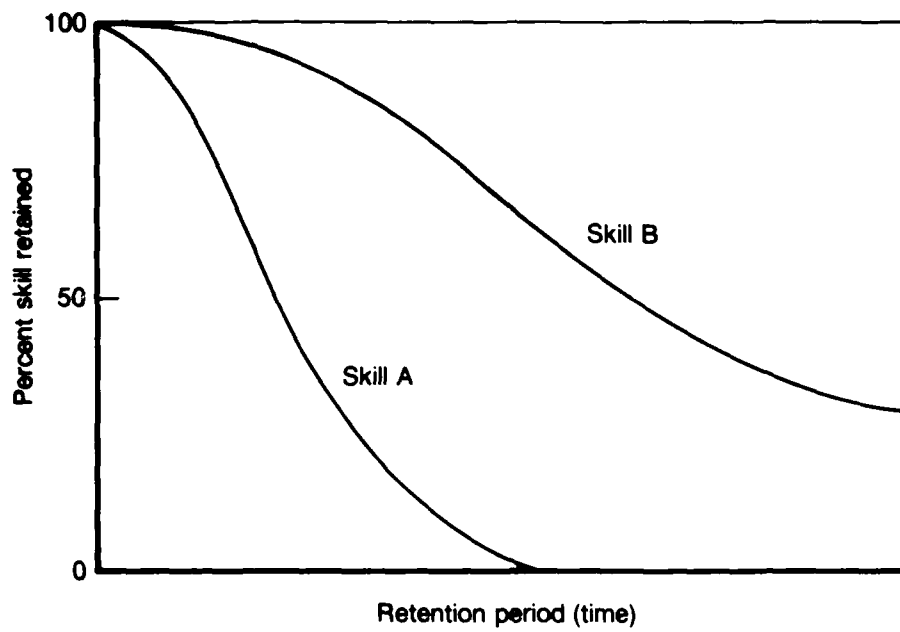


Fig. 7—Skills deteriorate at different rates

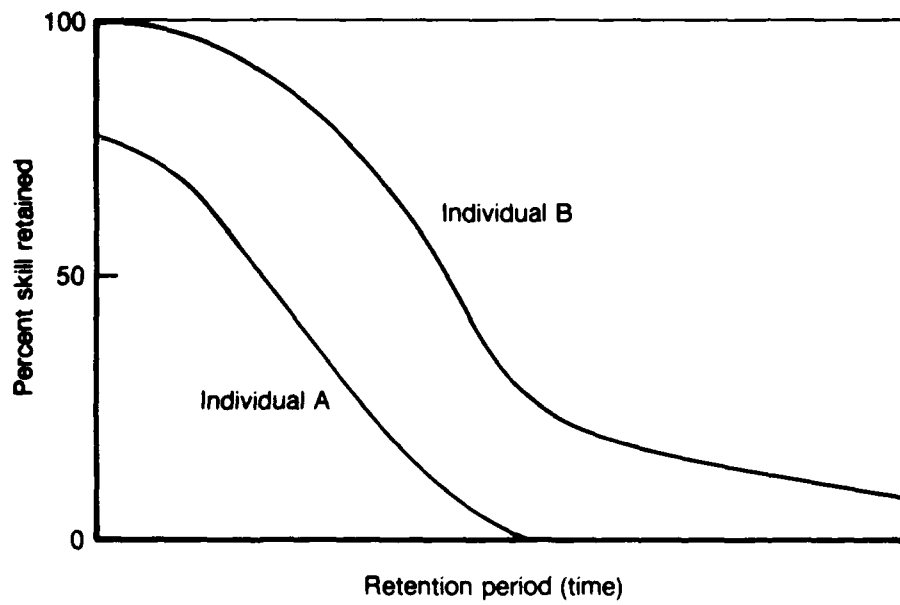


Fig. 8—Higher level of performance produces better retention

Speed or the ability to perform a task in a given period of time has been found to deteriorate rapidly. In a review of NASA spaceflight skills, Gardlin and Sitterly (1972) found that the ability to perform motor tasks in a specified period of time tends to deteriorate more rapidly than performance accuracy.

In addition to the Air Force studies, two Army studies investigated the relationship between task characteristics and retention. Shields, Goldberg, and Dressel (1979) studied retention of soldiering skills learned in basic training. Results indicated that for each task the percentage of soldiers who reached the minimum performance criterion declined over a 12-month period. However, some tasks deteriorated more rapidly than others. The best predictor of the rate of retention was the number of steps involved in the task.

Interestingly, even after 12 months, most tasks were not completely forgotten. Rather, soldiers performed many steps within each task, but not in the correct order. Further analysis of steps performed incorrectly or forgotten indicated that forgetting was not random. Soldiers tended to forget steps that were not cued by the equipment or a prior step, and they tended to forget safety steps.

A study by Osborn, Campbell, and Harris (1979) confirmed the non-random nature of forgotten steps. These researchers tested 89 armor crewmen for retention of crew-position tasks four to eight weeks after initial training. Task steps most likely to be forgotten were (a) steps at the beginning and end of a task and (b) steps related to safety.

In summary, while the literature indicates that skill retention for all tasks deteriorates, the rate of retention differs by task characteristics. Tasks with performance that deteriorates rapidly tend to be procedural, involve a number of steps, have no performance cues, and have time requirements. Tasks with performance that deteriorates more slowly are continuous tasks with cues or an obvious internal logic.



## INDIVIDUAL DIFFERENCES IN SKILL RETENTION

Individual differences have been examined as a possible predictor of skill retention. Research has found individual characteristics such as race, sex, and IQ to predict performance on a variety of cognitive and general ability tests. However, these variables have not been found to be good predictors of skill retention.

Vineberg (1975) examined the relationship between general ability, as measured by Armed Forces Qualification Test (AFQT) scores (categories II, III, and IV) and performance on 13 basic training tasks after a six week retention interval. Results indicated that the higher the AFQT categories, the better the performance at the end of basic training. However, after six weeks all three categories evidenced significant skill loss, and the loss occurred at approximately the same rate. This supports the basic concepts presented in Fig. 7.

Military experiments examined the relationship between prior experience and performance on repair skill tests (Spider, Harper, and Hays, 1985). In this study, intermediate (but not the highest) levels of experience and practice predicted higher performance, which in turn predicted higher retention levels.

Baldwin, Cliborn, and Foshett (1976) suggest that ability and training may interact to affect task performance. They find that post-training performance levels may differ for groups depending on the type of training employed.

In summary, research results indicate that the higher the level of skill proficiency at the end of training, the greater the retention. Thus, the best predictor of individual retention is the final performance level after training.

## REFRESHER TRAINING NEEDS

A few studies focused attention on refresher training for personnel on continuing active duty. A number of studies conducted for Air Force actives concluded that the time needed to refresh is less than the time needed for original training (Prophet, 1976). This finding is buttressed by Shields et al., who found that even with skill loss following a no-practice interval, residual skills remain.

Except for a few studies such as the above, both academic and military research has largely ignored refresher training. We found no empirical studies that linked task characteristics or individual characteristics to refresher training needs or time. Some studies did briefly discuss refresher training options, which in general follow those for original training.

## REFRESHER TRAINING METHODS

The training method which produces the highest original performance will produce the best retention over time. Since future IRR training may be intermittent, it is useful to examine the original training methods most associated with later high skill retention.

A characteristic frequently cited in the literature as related to high retention is overlearning, rather than learning to proficiency (i.e., one error-free trial completed within the prescribed time limit). Hagman (1980a), Goldberg, Drillings, and Dressel (1981), and Schendel and Hagman (1982) report that repetition or overlearning improves retention.

Quite a few Air Force, Army, and academic studies have examined the relative effects of massed vs. spaced practice (Schendel, Shields, and Kitz, 1978; Rose, McLaughlin, Felker, and Hagman, 1981). Findings indicate that spaced practice enhances skill acquisition and thereby leads to longer retention and reduced errors on subsequent tests.

In addition, Rose et al. (1981) found that tasks that were supported by job aids were retained longer. Job aids are written materials that are used in the normal performance of the job. For instance, mechanics normally use written handbooks in the diagnosis and repair of engine problems.

In summary, training of the IRR should focus on methods that produce the highest retention; these methods include mastery rather than proficiency training, spaced rather than massed trials, and the use of job aids where applicable.

## APPLICATION TO THE IRR

Even though the conclusions drawn from the literature are well supported, certain variables imbedded in the military experiments make application of the findings to members of the IRR tentative.

- Because members of the IRR will use their skills only in wartime, it is most important to determine members' skill retention on wartime tasks. Although some studies did focus mainly on wartime tasks, in many others the nature of the tasks was unclear or they were simply not applicable to the IRR enlisted population.
- The average IRR member will remain in the military from four to six years under the new military service obligation. Skills will have to be retained over this length of time. The academic and military literature, however, has used retention intervals of much shorter duration (see Table 2), most using retention intervals of less than six months.
- The research reviewed showed that the experience level of a test subject affects retention. The experience level of the subjects in the military experiments reviewed was usually not explicit. In two it was less than six months (see Table 2). The experience level of the average IRR member is expected to be higher--varying between three and four years on active military duty. This duty should reinforce learned skills to the point where they become automatic. Thus, we would expect the average IRR member's skill retention to vary significantly from some of the studies reviewed.
- The research indicates that the experience of the test subject during the retention interval will affect skill retention. Some experiences will reinforce skills; some will interfere with them. The military experiments reviewed did not control well for this variable. In many studies, the retention interval experience was not recorded, was uncontrolled, or the subject had regular active duty during the interval. In contrast, we expect IRR members to have civilian jobs and few military experiences.

Table 2  
VARIATION IN MILITARY STUDIES

Issue	Authors	Subjects	MOS/Task	Criterion	Test Interval
Task characteristics, predictors	Hagman, 1980a	60 student fuel and electrical repairers	63G MOS: test alternators	1 error-free trial for proficiency; 2, 3, or 4 for mastery	2 weeks
	Hagman, 1980b	45 ARI staff members	Move metal slide on rod, remember distance	Not specified	3 minutes to 24 hours
	Hagman, 1980a	30 student fuel and electrical repairers	63G MOS: test alternators	1 error-free trial	2 weeks
	Schendel & Hagman, 1982	39 reservists	Assemble and disassemble M60 machine gun	1 error-free trial	8 weeks
	Goldberg, Drillings, & Dressel, 1981	42 armor crewmen	19E MOS: boresight and zero the main gun of the M60A1 tank	1 error-free trial	5 weeks
	Hagman, 1980b	30 fuel and electrical repairers	636 MOS: repair alternators	Speed & accuracy, 1 correct performance	14 days
	Holgren, et al., 1979	138 Active Army, 106 National Guardsmen	Varied combat tasks	% students correctly performing tasks	8 weeks
	Shields, Goldberg, & Dressel, 1979	523 new soldiers	20 common soldier tasks	% soldiers performing each task correctly	7-12 weeks
	Osborn, Campbell, & Harris, 1979	89 armor crewmen	19E and 19F MOS: crew positions	Not specified	4-8 months
	Vineberg, 1975	200 new soldiers	13 basic training tasks	1 correct performance	6 weeks
	Baldwin, Cliborn & Foshett, 1976	61 air defense artillerymen	16P, 16R MOS: visual aircraft recognition	% aircraft recognized by group	Not specified

Table 2 (continued)

Issue	Authors	Subjects	MOS/Task	Criterion	Test Interval
Training characteristics, predictors	Mengelkoch, et al., 1960	26 naval pilots	120 procedural items and 5 flight control items	Not specified	4 months
	Adams & Hufford, 1962	20 naval pilots	Bomb toss from aircraft	Not specified	10 months
	Sitterly, 1974	45 nonpilots	Manual control of simulated spacecraft	Not specified	1-6 months

## IRR-SPECIFIC RESEARCH

We found no published empirical studies of IRR retention or training in our review. The services have, however, begun several programs. The Army began a new IRR training program in 1982. On an experimental basis, the Army brought in several groups of approximately 150 IRR members each for basic skill refresher courses. The program did not provide valid scientific evidence of IRR skill retention, but did provide some qualitative insights. According to after-action reports and Army personnel managers, the IRR groups studied showed significant declines in skill retention when initially tested. After a two-week, specially-designed program the groups had generally refreshed their skills. Although not specifically measured, indications were that most of the members were able to refresh their basic skills in less than two weeks--many within a few days.<sup>1</sup>

In 1986, as part of the muster program, the Army began testing IRR members to gather skill retention data that will later be analyzed and used to develop an effective refresher program. The tests are administered on a sample basis. In 1986, the Army tested approximately 4,300 IRR members on common tasks. In 1987, the Army will test IRR members in nine MOS codes identified as essential and having significant shortfalls in manpower needed for mobilization. By April 1987, over 40,000 IRR members with these primary MOS codes had been tested using written Standard Qualification tests. The data gathered from these extensive tests will be used to systematically determine skill retention in the IRR.

The Navy has begun a survey of the IRR in certain skill areas. A self-administered evaluation of skill retention, the survey lacks the objectivity needed to truly measure skill retention.

The Marine Corps is developing a model for skill retention and training needs. Unlike the other work reviewed here, the model firmly connects retention to refresher training options. This research is in the beginning stages and no empirical tests have been performed.

<sup>1</sup>After Action Reports for IRR exercises at Camp Atterbury, Ft. Ord, Ft. Lewis, and Ft. Knox were provided by Office of the Chief, Army Reserve Training Branch.

The Air Force has developed, and uses in its mobilization planning process, skill degradation factors that indicate, for each Air Force Specialty Code, the period since separation from active duty during which an officer or enlisted person could perform in the specialty. The factors range from six months (for pilots, navigators) to 10 years (personnel managers). Most maintenance occupations have degradation factors of 2-5 years. These factors, however, are based on the judgment of trainers and personnel managers rather than on empirical research. The Air Force has requested that the Human Resources Laboratory develop revised estimates of skill degradation factors based on empirical research, but no results are expected in the near future.

None of the above research projects has published findings. The research completed to date has been done on a very tentative basis as a way of surveying the problems involved in IRR skill retention and training.

#### SUMMARY AND RESEARCH IMPLICATIONS

In general, the literature indicates that, in the absence of practice or other reinforcement, skill retention deteriorates over time. Moreover, skill deterioration initially occurs quite rapidly, with the rate of retention decreasing over the retention interval, as shown in Fig. 6 (Adams, 1968). Individual skills are retained at different rates and retention follows a slightly different curve. In addition, each individual may retain skills differently. In general, it has been found that individuals with greater initial learning, as indicated on a performance test, retain skills longer, but the rate of decay for all individuals is about the same (see Fig. 7).

Relearning or refreshing skills has been shown to take significantly less time than did the original learning; however, few studies have attempted to quantify relearning needs or time.

In summary, although the research reviewed provides a rich background on skill retention, it does not provide the specific information needed to determine an IRR training program. It may nonetheless inform decisions on IRR training if additional consideration is given to the special circumstances of the IRR, in particular the

lengthy period since previous military training or experience, and the possibility of conflicts between civilian and military procedures for the same occupational task.

Research on the IRR needed to address these issues might include the following steps:

- The services should review IRR skill areas and choose several that are representative of the many types of skills demanded of the IRR population. For each of these skill areas the sub-tasks should be defined and described. Only wartime tasks should be included. This step has been performed for many skill areas already.
- Standard performance tests that are objectively judged with no observer interference should be developed for the above set of skills and tasks. The notion of a commonly used, objective performance standard is essential. In many of the studies reported previously, commander judgment of performance level was the criterion, making performance comparisons tenuous. (The tests currently being administered by the Army in its musters may meet the objectivity criterion.)
- Retention testing of a random sample of IRR members should be instituted. The testing would occur upon transfer from active duty, after every training experience, and during yearly musters. These data would form the baseline needed on normal skill retention within the IRR. The testing would be task specific, identifying those tasks that are particularly difficult to retain.
- In addition to skill retention measures, the IRR sample would be surveyed on retention interval experiences including civilian employment, years of service on active duty, time since transfer from active duty, and time since last training. At a minimum the survey should examine whether the individual's civilian experience reinforced his military skills. Results of retention tests would be stratified according to these variables. Performance tests would yield both group and individual scores, which could be compared to performance



levels at the end of training and at active duty separation. These comparisons would generate the task retention data.

Building on information about skills/tasks developed from the research suggested above, planners should develop refresher programs in accordance with four major parameters of training, as noted in the above discussion of the decision framework relevant to IRR training options:

- Frequency of training. How frequently should training be conducted to maintain a minimum performance standard?
- Duration of training. What length of time is necessary to refresh skills forgotten? One day, two weeks, longer?
- Type of training. Given the skill to be refreshed, what type of training is appropriate? Options include correspondence courses, pen and paper exercises, physical exercises, lectures, computer-assisted instruction, field training, unit training, or combinations of the above.
- Location of training. Given the skill to be refreshed, what is the most appropriate location? Unlike other military personnel, IRR members are dispersed geographically and not easily brought together for training. Options include the individual's home, local educational facilities, mobilization and recruiting stations, local military units, and centralized training facilities.

The reasoning linking skill retention information and parameters of a training program might take the following form: Procedural tasks are learned rapidly and decay rapidly. Decay and relearning are functions of task complexity and the number of discrete steps involved in a task. The literature indicates that 12 months after training, more than half the Army trainees can correctly perform tasks with fewer than nine steps. However, fewer than 10 percent can perform tasks with 15 steps. Given the 4-6 year no-training interval for most IRR members, complex tasks with 10 or more steps may need to be refreshed intermittently, at least every six months. In contrast, continuous tasks, such as aircraft tracking, take a long period to learn and deteriorate slowly. Tasks

such as these might best be refreshed during an intensive period at mobilization.

Procedural tasks like providing cardiopulmonary resuscitation (CPR) decay rapidly. They also have beginning and ending steps which are frequently forgotten. CPR could be refreshed by mailed written materials, followed by practice sessions at a common meeting place. Similarly, since safety steps are frequently forgotten, refresher training for combat tasks like loading and firing an M60 machine gun or M203 grenade launcher could be preceded by correspondence courses to refresh the IRR member's memory about task steps and their specific order.

In other words, many options exist for refresher training other than the two weeks of active duty training now being used by the Army. Research to date does not specify the proper refresher training program for any given skill. This can be remedied by using limited experiments, designed to associate knowledge of task retention with the training parameters defined above. Random samples of the IRR, who have complete baseline data on retention variables, should be given varying refresher programs. Each individual should be tested for relearning at controlled times during the experiment. Results would be stratified by the training parameters and analyzed for the best relearning results.

In addition to collecting test information, cost data on each program would be collected, as discussed further in the next section. Cost and relearning results must both be analyzed if a cost effective program for refresher training is to emerge.

## V. COSTS OF REFRESHER TRAINING

Different forms of refresher training--correspondence courses, classroom instruction, weekend drills--have varying costs. Unfortunately, current cost information for training IRR enlisted personnel is uneven and incomplete.<sup>1</sup> For a few types of refresher training, where procedures are well established and experience relatively great, cost figures are either available or readily estimated. Most types of training, however, are either untried (in an IRR context) or have been tested only in trial programs. Even the costs of trial programs are incomplete and collected piecemeal by several separate organizations, with no cost totals computed or analyzed. This is not to say that cost information for programming is not available; it is. Each of the services gathers sufficient information to program gross IRR training costs. This section, however, addresses the detailed cost information necessary to make subtle choices among training options.

The following paragraphs identify appropriate cost categories and procedures for determining the costs of IRR training. We then identify known costs for alternative training options and provide an example of approximate costs for single specialty. We conclude with a discussion of the data collection needed to improve cost estimates.

### THE COSTING PROCESS: SOME GENERAL GUIDELINES

As with any activity, costs for IRR refresher training will depend on choices as to how to implement that training. If minimal acceptable proficiency can be maintained by simply cycling IRR members through existing training regimens (either active duty courses or SR exercises), costs will be lower than if special programs are developed and

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<sup>1</sup>The costs of training *active duty* personnel are better known, being collected and reported by each of the services in a variety of ways ranging from total budgetary cost to average cost per trainee. Even these costs, however, are sometimes computed or used inappropriately.

implemented for the IRR. We anticipate that an IRR program targeted at tasks needed most upon mobilization (i.e., wartime tasks), implemented at the scale needed to train enough IRR members to meet mobilization goals, and of such brevity as to be reasonable for IRR members with employment and family commitments, will likely require specially designed courses used exclusively by the IRR.<sup>2</sup> Much of the discussion of specific cost data below focuses on such special courses. Regardless of whether special courses are developed, however, or IRR training is piggybacked onto existing training programs, some general guidelines indicating how to appropriately determine the costs of training can be identified.

### What to Include

To estimate the costs of different training options, the first requirement is a comprehensive list of the activities that will be involved in the training program. At a minimum, estimates useful in comparing different forms of training should include:

- The cost of centralized management and monitoring of training activities for IRR members.
- The cost of developing and validating the program of instruction (POI), course curriculum, etc.
- For other than correspondence courses, the increase in base support costs at the installation where training occurs.
- The cost of planning and coordinating for the influx of IRR members at the training installation (e.g., arranging transportation, base housing).
- The cost of instructor time and nondurable course materials.
- The cost of maintenance and depreciation of durable equipment.
- The cost of travel, pay, and per diem of trainees.

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<sup>2</sup>An exception may be Army Training Extension Courses (TECs)--slide-sound presentations on selected tasks that have been developed to refresh the individual skills of active duty enlisted personnel while they are on duty with their units.

## How to Record Costs

Cost data will be most useful to estimate the total cost of training of different types, intensities, and scale if certain types of costs are distinguished from one another.

**Costs that are invariant to training method.** Some costs inherent in monitoring and managing an IRR training program vary with the scale of training but not with the type of training. Any systematic attempt at training will require some means of keeping track of reservists--their attributes, past training, and current status. Also necessary will be counseling or guidance services of some kind, to provide information for reservists and to answer their questions. Although details of this management system (which presumably would be located at the reserve personnel headquarters for each service) will depend on the type of training envisioned, the basic requirements of the system will not.

The total cost of these functions may well vary with the number of IRR members who are eligible for training or who are intensively managed, but it will probably matter little whether the training takes the form of two weeks of counterpart training or one day of computer-assisted instruction at the nearest training installation. Management costs thus are important to the decision concerning the frequency and scope of refresher training, but will have little effect on decisions regarding the duration or form of that training.

**Costs that vary with training method, but are invariant to training load.** Costs associated with developing a course of training depend crucially on the type of training, but do not vary with the number of IRR personnel put through the course. That is, the cost of developing a POI for a two-week field training course to refresh skill level 1 tasks for infantry will be quite different from the cost of producing a 55-minute slide-sound presentation for refreshing first-aid skills, but the cost will not change whether 5 or 5,000 reserve personnel take the training. Thus, total development costs for the course of instruction will not depend on student load, although *per trainee* costs certainly will--as the development costs are spread out over more enrollees, the per student cost will drop. For training cost estimates it is usually

easiest to compute these fixed costs separately from costs whose level increases with training load.

**Method-specific costs that vary with the training load.** Probably the largest category of costs will be those that will vary with both the type of training and the training load. By "type of training," we mean location and duration as well as the form of instruction (conventional classroom instruction, unit training). This category of costs includes ammunition, instructors' pay, trainee travel, and so forth. It also includes those portions of total "overhead" costs that increase as the student load increases--base support costs, maintenance costs for any equipment used, and other.

Average cost per person for these activities may increase, decrease, or stay the same with increases in the number of reservists trained. For example, pay and allowances per trainee will stay approximately constant no matter how many there are. In contrast, for activities such as in- and out-processing, on-site preparation and planning for training, economies of scale are likely--it costs more to in-process 100 IRR personnel than it does to in-process 10, but not 10 times as much. For these kinds of costs--where efficiency increases with the training load--per-person cost estimates based on one training load (e.g., from a trial training exercise) should not be used to cost a training program of the same type but a larger (or smaller) scale. Unfortunately, many costs of this type currently are reported as average costs per student. Costs reported in this form are not useful for predicting the costs of alternative training loads without further information as to whether average costs will rise or fall at different loads.

Method-specific training costs may vary with the duration of training as well as with the student load. A four-day field refresher course will cost less than a two-week one; a single correspondence course lesson will cost less than a series of lessons. As with the relation between costs and training load, the cost increases may either be proportional to the increase in length or the per-day cost may fall as the duration of the course increases. And as in the previous case, per-day cost estimates may not be accurate indicators of the per-day costs of similar courses conducted at greater (or lesser) length.

### Costing for Policy Decisions: Incremental Costs and the Allocation of Joint Costs

Some costs do not change with choice of training type and duration. In policy decisions about type and duration, these costs are in a very real sense irrelevant, because no such choice will affect them. The costs that should be considered are the *incremental* costs of training--i.e., the costs that increase if training of that type is done more often, or for longer periods, or at higher training loads.

The incremental cost approach becomes important for joint costs--the costs of activities that contribute simultaneously to several different goals. In the case of IRR training, there are at least two major cost elements that fall in this category. First is the cost of instructors and support people when the training is provided by personnel whose cost would be incurred by the military regardless of the IRR. For example, IRR training may be provided by Selected Reserve training units as part of their two weeks of annual training (or, potentially, as part of their weekend drills). Or IRR members may participate in ongoing classroom instruction provided for the active forces but operating at less than full capacity. The training personnel then contribute simultaneously to more than one objective--training both the SR and the IRR on annual training tours, and training both active and IRR soldiers when ongoing active duty courses are "topped up" with IRR personnel. The choice of how much, if any, of the budgetary costs of the instructors to attribute to the IRR is arbitrary in this situation (as with any apportionment of joint costs among multiple products). For purposes of policy decisions, however, the appropriate allocation is more clear-cut: If IRR training increases costs to the unit providing the training, then the increase should be included in any estimate of full costs of training the IRR. If the training unit's costs are not increased, they should not be considered as part of IRR training costs.

If using SR or active military personnel for training the IRR replaces some other activity, the situation becomes more complex. For example, if SR combat units are used, the costs of replacing those SR units in other activities, and the experience/training forgone by the SR

as a result of missing those other activities, need to be considered as part of the full cost of training IRR personnel.

A second element that may be a joint cost is the cost of developing the curriculum or POI needed for a particular training option. For some types of training, such as slide presentations and formal school courses, the IRR can use "as is" a course developed and tested for use by the active forces. Thus there are no incremental costs for course development attributable to the IRR. More often, a course will be available, but will need modifying before being used by the IRR.

With the possible exception of the Army's TEC courses, which are designed for enlistees who have completed formal training and have some experience, it is likely that courses designed for active duty personnel will benefit from some pruning, either to eliminate non-critical tasks or to minimize introductory material not needed by reservists with active duty experience. Of course, the costs of modifying a course of instruction originally designed for another component of the service, as well as periodic update costs for either modified or custom-designed courses, are incremental costs incurred because of IRR training and should be included in estimates of the full costs of IRR training options.

### **A Caveat on Cost Comparisons**

An obvious but sometimes overlooked point should be noted before we proceed to actual cost estimates: costs for different types and lengths of training, no matter how carefully calculated, cannot be considered in isolation. Training regimens that are costlier, because custom-designed, may be more productive because they focus on specific skills identified as critical to readiness, or subject to rapid decay. Also, longer--and therefore more costly--courses will enable training to a higher level. Thus, options with different costs may result in different outcomes, making strict comparison of cost effectiveness of the training alternatives difficult. Prudent management of IRR training requires choosing the least-cost training option to reach a predetermined level of achievement. The options whose costs are discussed below are appropriate for training different kinds of skills, to different proficiency levels. Any decision on the mix of training



options to use, thus, will necessarily be a choice based on cost *relative to outcome*.

## CURRENT COST ESTIMATES

Costing of refresher training options for the IRR is at a stage best described as embryonic. For types of training that would be unique to the IRR,<sup>3</sup> the available numbers derive from a small number of sources: (1) the four two-week trial courses for IRR undertaken by the Army in FY 83 and 84 (at Fort Ord, Fort Lewis, Camp Atterbury, and Fort Knox); (2) the counterpart training program that has traditionally been the largest source of IRR training, but is not well targeted at critical skills; or (3) cost estimates for the few activities that are part of one or another training options (pay and allowances for trainees based on pay grades and pay tables, uniform costs based on prices of new and used uniforms).

All current cost estimates are incomplete because not all activities related to training are included. In addition, when cost figures are available, they are widely scattered, collected by different commands under different guidelines. For example, a full costing of the Army's IRR trial refresher programs for infantry and armor would need to gather cost data from:

- The Training and Doctrine Command (TRADOC), which bears the costs of the development of the POIs used in the exercise.
- The Army Reserve Personnel Center (ARPERCEN), which bears the costs of selecting and notifying the IRR members who are to participate, and the costs of travel and pay (including per diem) of the participants.
- The Selected Reserve training division conducting the exercise, which absorbs the costs of planning, coordinating, and conducting the on-post activities for the training period.

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<sup>3</sup>Costs for courses given to active duty personnel, which may also be considered for IRR personnel, are better known and based on long experience.

- The training post, to the extent the facility provides general support (food service, military police, transportation) to the IRR and trainers.
- The active duty unit that provides ammunition.

For types of refresher training other than the trial programs used so far, different types of cost data are relevant. Table 3 reports the current status of cost information for training options for the Army's IRR. For each training option, the cost element is judged as to whether it is (a) known (even if it is in an inconvenient form or is difficult to locate), (b) not known, but relatively easily constructed or estimated from known data on required inputs and their prices, or (c) not known and not easily constructed or estimated. Table 4 presents similar information for refresher training options in the Marine Corps.

Costs that are not specific to training method--most notably costs of IRR personnel management conducted at the Reserve Personnel Centers in each service--do not appear in Tables 3 and 4. Little is known about the magnitude of these costs; they fall under the category "not known and not easily estimated."

In addition to the outright unknowns, some cost elements in Table 3 are of questionable accuracy. The elements that apply to unit field training in the Army derive from one-time trials of refresher training courses. Although useful in the absence of other information on the costs of unit training for the IRR, these numbers fail to distinguish between activities where the per-trainee costs remained constant as the programs were expanded and where they fell, so they are not suitable for estimating costs for larger scale training programs. In addition, trial programs may well have higher costs than an ongoing operation because experience will reveal more efficient ways of doing things.

More generally, some costs that appear in Table 3 as "known" are being reported inappropriately. Costs are usually reported as average cost per trainee per day. When some costs (e.g., travel costs, in-processing costs) stay the same regardless of the duration of training, and others (e.g., planning costs) stay the same regardless of number of trainees, average cost figures are not as helpful. Total cost

Table 3  
STATUS OF COST INFORMATION IN THE ARMY

Cost Element	Correspondence Course	Type of Instruction			Field Training Counterpart	Unit
		Conventional	Classroom Instruction TEC(a)	CAI(b)		
Course or POI development	C	C	C	C	n.a.	U
Payments to trainee						
Travel	n.a.	C	C	C	K	K
Pay & per diem	C	C	C	C	K	K
Equipment						
Uniforms	n.a.	n.a.	n.a.	n.a.	C	C
Ammunition	n.a.	n.a.	n.a.	n.a.	U	C
All other	U	U	C	U	U	U
Activities at the training location						
Pretraining planning	U	U	U	U	U	C
In- and out-processing	U	U	U	U	U	C
Instructors	n.a.	C	C	C	n.a.	C
Support (food, MPs, transportation)	U	U	U	U	U	U

NOTES:

K known--cost data in some form are currently available.

C Constructable--cost data are not now available, but can be constructed or estimated from known input and price data.

U Unknown--cost data are not available and cannot be constructed on the basis of current information.

n.a. Not applicable to this training method.

(a) Training Extension Course: a system of self-paced audiovisual lessons designed by the Army to aid in ongoing individual instruction of personnel on active duty.

(b) Computer Assisted Instruction: learning aided by computer.

Table 4  
STATUS OF COST INFORMATION IN THE MARINE CORPS

Cost Element	Correspondence Course	Type of Instruction		
		Classroom Instruction Conventional	CAI(a)	Field Training Counterpart Unit
Course or PO development	U	U	U	n.a.
Payments to trainee				
Travel	n.a.	C	C	K C
Pay & per diem	C	C	C	K C
Equipment				
Uniforms	n.a.	n.a.	n.a.	U
Ammunition	n.a.	n.a.	n.a.	U C
All other	U	U	U	U
Activities at the training location				
Pretraining planning	U	U	U	U
on- and out-processing	U	U	U	U
Instructors	n.a.	C	U	n.a. U
Support (food, MPs, transportation)	U	U	U	U

Notes: \* Known-cost data in some form are currently available.

† Constructable--cost data are not now available, but can be constructed or estimated from known cost and price data.

‡ Unconstructable--cost data are not available and cannot be constructed on the basis of current information.

n.a. Not applicable to this training method.

(a) Computer Assisted Instruction, learning aided by computer.

figures are needed as well as information on how rapidly costs will change with changes in training load or duration. Although some elements are useful in per-trainee, per-day terms (pay and per diem, for example), the accounting framework currently used, which reports all costs this way, needs revision.

To give an idea of the order of magnitude of the costs of different training options, and to illustrate one useful format for reporting costs, we have developed some very rough estimates of the costs of training Army enlisted IRR personnel in MOS 11B: infantry. The costs for specified lengths and forms of training appear in Table 5. Infantry was chosen for this example because far more is known about costs for refresher training in this occupational specialty than in others. Even so, the costs in the table are rudimentary, and should be considered illustrative only--they give an indication of order of magnitude, and of a way in which cost figures can usefully be reported. Costs for which we could find no information are indicated with an asterisk.

Because we have designed Table 5 to illustrate cost comparisons of alternative training technologies and duration, we do not include costs that do not vary with the training method chosen. Specifically, we have excluded the costs of counseling, notifying, and managing trainees prior to the training episode.

Costs that vary with training method are divided in Table 5 into three categories. The first panel shows costs that do not change with increases or decreases in training load. Unfortunately, we could find little information on the major such cost--course development. For counterpart training, this cost is zero. For the other forms of training used as examples in Table 5, we have no current information.\*

The second panel in Table 5 presents rough figures for costs that increase as the training load increases, and where the cost increase can reasonably be assumed to be proportional to the load increase. Because cost per trainee is the same regardless of the number of trainees for these cost elements (that is, because average costs are constant), these

\*Course development costs for contract training courses were estimated by the Army Research Institute in 1964 as \$1,400 per course, with no provision made for more recent cost estimates. (See footnote 1, p. 47.)

Table 5

THE COST TO TRAIN 11B ELISTED PERSONNEL, BY TYPE AND DURATION OF TRAINING  
(1985 dollars)

Cost Element	Type of Instruction									
	Classroom Instruction					Field Training				
	Correspondence Course (20 lessons)	Conventional 2 day	TEC(a) 4 days	CAI(b) 2 day	Counterpart 7 days	14 days	7 days	14 days	7 days	14 days
I. FIXED COSTS--INVARIANT TO TRAINING LOAD										
Course development	*	*	*	*	0	0	*	*	*	*
II. STABLE VARIABLE COSTS--CONSTANT COST PER TRAINEE (Dollars per trainee per training episode)										
Trainee pay & per diem	*	100	200	100	420	840	420	840	420	840
Travel	0	150	150	150	300	300	300	300	300	300
Uniforms	0	*	*	*	50	50	65	65	65	65
Ammunition	0	0	0	0	*	*	300	500	300	500
Other material support(d)	*	*	*	*	15	30	100	200	100	200
III. DECREASING VARIABLE COSTS--COST PER TRAINEE CHANGES WITH NUMBER OF TRAINEES (Total cost per episode for 1000 trainees)										
Instructor preparation, base planning & coordination	*	*	*	*	1,500	1,500	22,500	30,000	22,500	30,000
In- and out-processing	0	*	*	*	0	0	700	700	700	700
Instructor pay	*	*	*	*	0	0	0	0	0	0
Support personnel pay	*	*	*	*	0	0	0	0	0	0
IV. TOTAL VARIABLE COSTS FOR 1000 TRAINEES										
Stable costs					785,000	1,220,000	1,185,000	1,905,000	1,185,000	1,905,000
Decreasing costs					1,500	1,500	23,200	30,700	23,200	30,700
TOTAL					786,500	1,221,500	1,208,200	1,935,700	1,208,200	1,935,700

Table 5 (continued)

SOURCES:

Trainee pay and per diem: Field training: Actual FY 85 cost as reported by ARPERCEN. Classroom instruction: Assumes pay rate is for an E-3, at the rate reported for 1985 by ARPERCEN, plus some per diem. Per diem is arbitrarily set at 50 percent of field training per diem costs reported for 1985 by ARPERCEN.

Travel: Field training: ARPERCEN Comptroller's Office, based on actual FY 85 costs for training tours. All other types of instruction: Assumes training will occur closer to trainee's home; 50 percent of field training travel costs is assumed arbitrarily.

Uniforms: Assumes 2 sets of battle dress uniforms for counterpart training and 3 sets for unit training, plus other uniform essentials (e.g., boots); assumes summer uniforms; assumes some resale value. "MOB Study Fact Sheet," 1 May 1985.

Ammunition: Costs for 14-day field exercise is computed from "ARSTAF PDIP Issue," which estimates budget costs for S11 refresher training for an unspecified MOS for FY 86 through FY 90. Costs for 7-day field exercise are computed assuming more ammo-intensive training in the shorter course. An arbitrary 125 percent of per-day ammo requirement for the longer course is assumed.

Other material support: Based on costs reported in Fort Ord After Action Report for purchases from supply at Fort Ord.

Instructor preparation, base planning & coordination: We begin with the information in the Fort Ord After Action Report, which cites 100 officer mandays and 310 enlisted mandays of planning for one 14-day unit training session. We cost these days at \$80 per officer day and \$45 per enlisted day. Because it seems likely that such costs will drop dramatically when training becomes routine rather than as a trial program, we divide by 3 to allow for economies of scale and experience. Finally, the After Action Report states 280 enlisted could have been trained with no increase in costs, so we assume four separate training sessions would be needed for 1,000 enlistees. This yields the cost for a 14-day course. Costs for 7-day unit training course and counterpart training are arbitrarily set at 75 percent and 5 percent of the costs of the 14-day course.

In and out processing: Based on the Fort Ord After Action Report, we assume 4 enlisted days at \$45 per day for processing for one 14-day unit training session of up to 280 enlistees. We assume 4 sessions will train 1,000 enlistees. We assume processing costs are the same regardless of length of unit training, and that processing costs for counterpart personnel are minimal.

Instructor pay & other support personnel pay: We assume these come from Selected Reserve unit on annual training days; therefore we assume zero incremental costs for field training of IRR.

NOTES:

\* Indicates no cost estimate currently available.

(a) Training Extension Course

(b) Computer-Assisted Instruction

(c) Refresher training in a central location for a large number of IRR at once (150-300 reservists per session; similar to training undertaken in 1984 at Fort Lewis and Fort Ord).

(d) Includes food and transportation for all personnel while on training exercises.

figures can be scaled up or down to provide valid cost estimates for alternative class sizes. These figures can thus be appropriately reported on a per-trainee basis, as in Table 5.

The cost elements shown in the third panel of the table are reported in terms of total cost for a specified number of trainees-- in this case, 1,000 infantry trainees. These are costs that increase with training load, but increase less than proportionately over some relevant range. Thus, 1,000 trainees will not cost twice as much to prepare for, and process, as 500 trainees, so reporting costs as "costs per trainee" can be misleading.

Included in the decreasing costs panel of Table 5 is the pay of instructors and support personnel. We arbitrarily assume that there will be no additional costs to the military for instructors, because we assume they will be provided by Selected Reserve training units on annual training. These personnel will be paid whether the two weeks are spent in training IRR members or on some other mission, and we assume that the process of training the IRR contributes at least as much to SR readiness as any alternative use of their annual training time.

The bottom panel of Table 5 combines the costs of the previous three panels, all calculated in terms of total costs for 1,000 trainees.

Of course, costs will be different not only for different forms of training, but also for training in different specialties. Course development and equipment costs will be especially variable across occupations. Nonetheless, the figures in Table 5 are useful because they indicate the extent to which costs will be misestimated if the only costs considered are those that currently appear as IRR costs in the Army budget. Those budget figures include little other than trainee pay and travel expenses. Although a significant portion of total costs, they may provide a misleading indication of how the total costs of training options compare with one another. This will be especially true if instructor time is included in the cost totals (which it is not in Table 5).



## REQUIREMENTS FOR FURTHER DATA COLLECTION

Informed decisions among training options for the IRR require cost estimates for all the cells in Tables 3 and 4. It is unlikely that exact computations can be performed, but rough estimates should be possible. Some cost elements now available need to be recast in a form more useful for cost projections. Specifically, cost numbers that are reported as average cost per trainee per day, the predominant form now used, should be reconfigured to separate costs that are fixed regardless of length of training (e.g., travel costs for trainees) from costs that change with training load (most types of planning and processing costs). Thus, costs for each category listed in Tables 3 and 4 should be divided into: (1) fixed costs, invariant to training duration or load, reported as a total, *not averaged out over an arbitrary number of enrollees and days*; and (2) incremental costs, which should be reported as costs per additional person or day of training. This reporting procedure would not increase the amount of data to be collected--the same component parts must be collected to compute cost per trainee per day. But it would allow planners to adjust the cost figures appropriately for alternative possible training loads and course lengths, which cannot be done with the costs as they are reported today.

In addition to changes to reporting, IRR management would benefit greatly from data on currently unknown costs, and the validation of cost data now based solely on a handful of trial training exercises. Probably the first priority in this area is to collect data on the costs of instructor time (where instruction cannot be done by SR units as part of their training) and the costs of planning the exercises and processing the trainees who attend them. For any large scale refresher training program, these will be recurring, reasonably large costs not now known.

Cost estimates for a variety of training options are also needed. The current Army choice--two-week refresher training in the field for a group of 100-200 IRR members--may be cost-effective, or it may not. It is difficult to judge in the absence of cost estimates for alternative types of instruction.

For any type of training, cost estimates at this stage will be somewhat speculative. Costs will vary with the details of the program of instruction, which may not be well developed for all specialties. With some additional data collection effort, however, it should be possible to roughly estimate the major costs for the important career fields and for the most promising training options. Such information is essential for informed selection among refresher training options for IRR personnel.

## VI. A COMMENT ON THE COMMITMENT OF IRR VOLUNTEERS

In addition to cost, a major issue in the formulation of an IRR refresher training program is whether IRR members will show up for refresher training, for how long, and how frequently. As with costs, little concrete information exists.

By law the services may *require* training by any Ready Reservist for up to 30 days per year. But current policy is to rely on voluntary training, probably for no more than two weeks per year.

The Army, Marine Corps, and Navy provide training opportunities for their IRR on a voluntary basis. The Air Force does not. In FY1985, less than 5 percent of the enlisted IRR showed up for training (this does not count Individual Mobilization Augmentees participation). Some individuals may have been counted twice, so 5 percent is actually an overestimate of participation. This participation rate is an increase compared to years past.

Many factors might contribute to low participation rates.

- The services base their IRR budget allocations on incremental increases in past funding. The budgets have never reflected the demand by IRR members for training opportunities. The services contact individuals to participate in training until the budgeted funds give out. This is not to say that a great pent-up demand for training exists, but with increased funds more IRR could be contacted and more might train. The Army estimates that even its current IRR training program is underfunded.
- Better methods of informing the IRR members of training opportunities may improve participation. Although the services brief each IRR member on his or her IRR duties at transfer from active duty, the services indicate that many remain unaware of their eight-year military service obligation or of training opportunities. Pamphlets, magazine articles, and the like are used in mass mailings to contact the IRR about training

programs. IRR managers at the personnel centers indicate that personal telephone calls produce the greatest number of volunteers, yet the services are not able to contact each IRR member because of lack of manpower.

- The limited training opportunities now offered may not interest the IRR member. Research on Selected Reservists indicates that unsatisfactory training content is a major consideration for those who quit (National Guard Bureau, 1977). Similar research has not been done for the IRR.
- In recent IRR trial training programs, the Army has constructed a standard package of two weeks of active duty; some planning documents imply annual active-duty periods of such length for the duration of the enlistee's IRR membership. This length of annual training may be too long for IRR members who are employed or who have strong family commitments.
- Employer attitude toward reservists' absences may discourage IRR members from attendance.
- Reimbursement for training may not be high enough to encourage IRR members to take time away from other employment activities and family.

Discussions with IRR managers at service personnel centers indicate little is known about IRR willingness to train. Without further information on what keeps the IRR from training now, a practical training program cannot be implemented. Solutions to these problems may include increased funding, better methods of contact, more diverse training options, employer awareness programs, and higher reimbursement rates. It may be that nothing short of compulsory attendance will generate the desired participation rates. Choice among possible solutions rests on a specific diagnosis of the causes of low participation. Thus, we recommend surveys of a sample of IRR personnel, both those who do and those who do not train, to determine the factors that affect their participation. Employer surveys or promotion campaigns may also be necessary.

A secondary issue, not addressed here, is the effect of increased or decreased training opportunities on the retention of those few IRR members who choose to reenlist in the IRR after their mandatory service length.

## VII. CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations are given at the end of each section of this Note. We summarize them here, but suggest that the reader refer to each section for more specific information, especially regarding proposed research agendas.

Whether to refresher train an enlisted IRR member must be decided in the context of the need for the member's skills at mobilization, and tradeoffs between costs incurred before mobilization versus time and effectiveness gained at mobilization. We found the services' perceptions of the nature and scope of these tradeoffs to be unclear, primarily because little attention has been focused on the IRR. The services are only now developing decision frameworks that will enable them to make the necessary tradeoffs.

We recommend that decision frameworks for IRR training take into account the usefulness of other mobilization assets, the time and resources available at mobilization for IRR training, the skills that are critical to mobilization, and cost concerns. This decision framework must be supported by further information on skill retention in the IRR, training needs of the IRR, costs of refresher training, and the willingness of the IRR to train. Currently, the services have little information in any of these areas.

Although information on the general retention of military skills does exist, the skill retention of the IRR population has not been measured. This can be remedied by performing controlled experiments and surveys that can be implemented during required musters or during voluntary training sessions. Likely predictors that should be measured for a sample of participants are task characteristics, performance after the last training session, and intervening civilian experiences. Individual characteristics such as IQ, age, sex, race are much less likely to produce the predictors needed. In addition, routine performance testing of all members at transfer into the IRR and after refresher training sessions should be implemented.

The literature we reviewed was uniformly lacking on refresher training needs and options. Thus, the above experiments should turn considerable attention to producing information on this area. The literature review indicated that a refresher program could and should offer a diverse spectrum of training packages that include mailed written materials, correspondence courses, individual training, classroom work, and unit field training.

The costs of IRP training remain unknown at this point. Data are only now being collected from experiments in the Army, albeit often in a disjointed and incomplete fashion. The usefulness of the cost data depends on their accuracy, inclusiveness, and reporting format. To make valid comparisons between training options requires that the costs be differentiated, as proposed in Sec. V, between per-trainee costs that change little with the scale of the training, and those that vary significantly.

Finally, woefully little information exists on the willingness of IRR members to train at all, much less for several weeks. Again, the required annual musters offer an excellent opportunity to develop this information through a survey instrument. Important parameters include effectiveness of varying types of contact, importance of training content, effect of employer's attitude, reimbursement, family concerns, and increased service manpower.

It is clear that the issues surrounding IRR training cannot now be settled in a satisfactory manner. The information simply does not exist for informed decisions. We think, however, that the information needed can be obtained quickly, without extensive additional research, by modifying existing programs to enable collection of the information desired. Also, many tasks are common across the services, thus reducing the need for extensive testing if the services can coordinate their approaches and share their results.

## Appendix

### REVIEW OF THE LITERATURE ON SKILL RETENTION

This appendix summarizes major findings and theories concerning skill retention which are relevant to maintaining IRR readiness for mobilization. Based primarily on literature reviews and psychology texts produced over the last 25 years, this survey documents the psychological premises for the recommendations in Sec. IV.

#### DEFINITIONS OF SKILLS, ABILITY, AND PERFORMANCE

Definitions of skills vary, although most definitions include the concept of acquisition through some kind of training. For example, A. T. Welford (1976) defines a skill as the:

Quality of performance which does not depend solely upon a person's fundamental, innate capacities, but must be developed through training, practice, and experience.

H.T.A. Whiting (1975) offers a similar definition in the context of the nervous system:

Complex, intentional actions involving a whole chain of sensory, central, and motor mechanisms which through the process of learning have come to be organized and coordinated in such a way as to achieve predetermined objectives with maximum certainty.

The existence of an objective in a skilled performance distinguishes skills from abilities (Singer, 1968; Whiting, 1975). Skills are task-oriented. Abilities are more general traits, held before the individual is trained to acquire the habits and subskills of a given task (Whiting, 1975). Skill acquisition does not increase these basic capacities, but does "improve the efficiency and effectiveness with which they are used" (Welford, 1976).



The distinction between the two is important for this study because research indicates that the skills required to perform individual tasks remain unique, despite the fact that they may be based on similar abilities. Ability, therefore, cannot be used as a good predictor of ultimate skill attainment because abilities combine with other factors in the process of skill attainment in dissimilar ways (Singer, 1968).

Another distinction which complicates the measurement of skill attainment is the difference between a learned skill and the performance of that skill. Based on learning theory, this "distinction says that all relevant variables determine momentary performance, but only a subset of them defines habits of learning states" (Adams, 1967). For example, performance of a skill may be measured under conditions of fatigue, disorienting environment, or other factors which influence the results to include more than a measure of skill. Performance, therefore, can be affected by changing such non-skill-related variables as motivation and work inhibition (Adams, 1967).

Finally, it should be noted that the literature refers to various kinds of skills, including motor, verbal, perceptual, and cognitive. Different groupings are used, such as perceptual-motor skills and language skills. Another categorization contrasts perceptual-motor skills and mental or intellectual skills which link perceptions to decisions and actions (Whiting, 1975; Welford, 1976). However, there is considerable evidence that these skills overlap. For example, motor skill learning often involves verbal skills and vice versa. Motor skills cannot be employed without some sensory skills providing spatial and temporal inputs. For the purposes of this study, we identify verbal, motor, and cognitive skills--or skills of language (symbolic relations), muscular coordination, and recognition/judgment (problem solving).

#### CONCEPT OF SKILL RETENTION/DECREMENT

Retention of a skill is often defined as the result of several steps. First the initial acquisition of the skill, followed by a retention interval during which the subject does not use the skill. After an interval, the subject is called upon to take a retention test

during which the subject either recalls or recognizes correctly (Adams, 1967).

Researchers have applied a number of models to understand the acquisition and retention of a skill. Basically, they incorporate the following elements into the process (based on Welford, 1976; Adams, 1967):

1. Comprehension of the task. Various training techniques have been developed to aid in this process.
2. Temporary storage of task habits in a short-term or immediate memory. The short-term memory appears to be physically separate from the long-term memory, of limited capacity and easily distracted. Certain training techniques, such as splitting up tasks which involve substantial amounts of learning, can be employed to aid this stage of retention.
3. Transference from the temporary storage of the short-term memory to that of the long-term memory functions as a buffer. Practice and experience move the material to long-term storage. During this stage any initial errors should be removed.
4. Long-term retention or storage. The stored data can be modified if similar material is stored later.
5. Retrieval for use. Conditions of the retrieval can aid the process. Moreover, predetermined associations can be formed to make retrieval easier.

Although most skills decay over time, time in itself is not considered the determining factor in forgetting. Rather, the widely accepted interference theory holds that forgetting is due to "competing responses learned before acquisition of criterion responses (proactive inhibition), or in the retention interval (retroactive inhibition)" (Adams, 1967). Interference becomes a factor throughout the process described above. Even when once stored in long-term retention, modifications can result from competing, similar material.

Concepts of short and long term are relative. The short-term memory is immediate. Most studies measure "long-term" retention in days, weeks, and months. Rarely do studies extend to one or more years, a period of time more appropriate to the IRR.

## RETENTION OF DIFFERENT TYPES OF SKILLS

In general, some kinds of skills tend to be retained longer than others. This is particularly true with two kinds of motor skills--continuous and discrete. Continuous motor responses are those that involve the repetition of a movement pattern which has no discernible beginning or end, such as riding a bicycle. Discrete responses are usually of short duration and have a well-defined beginning and end, such as moving a gear shift or firing a rifle. Procedural tasks are a series of discrete responses, such as assembling a rifle or operating a radio communications system. Continuous motor skills decay slowly over periods of months and years. Discrete and procedural tasks decay quickly over a period of days, weeks, or months. Unlike continuous motor skills, procedural proficiency cannot be maintained in the absence of practice (Schendel et al., 1978).

Relative retention rates of other skills vary. Decay of verbal skills, which can contribute to procedural tasks, is similar to that of discrete motor skills (Adams, 1967). Temporal aspects of motor skills (the time it takes to complete a task) tend to deteriorate more rapidly than accuracy of performance (Gardlin and Sitterly, 1972).

The differences in retention rates among various types of skills may actually reflect the nature of the tasks. By definition, continuous motor skills involve repetition and therefore, probably result in overlearning, a factor associated with increased retention periods (Schendel et al., 1978; Adams, 1967). In addition, continuous motor skills are generally much more highly organized than other skills (Gardlin and Sitterly, 1972; Schendel et al., 1978).

Characteristics of discrete and procedural tasks appear to create lower retention periods. For example, procedural tasks often have a verbal component which probably contributes to the skill decay (Schendel et al., 1978; Adams, 1967). Because the procedural task includes a variety of steps and choices, it is necessary to retain not only the knowledge of how to do something, but of what to do as well.

Some procedural tasks are retained for longer periods than others because of their characteristics. For example, the more relevant or critical particular steps are to performance, the more likely they are

to be retained. (Thus, safety steps are often forgotten.) Moreover, the logic of the sequence may also affect retention--i.e., the more obviously one step emerges from the previous one, the more likely it is to be retained. Finally, the more complex the procedure, the more effective are the use of supplemental memory aids (Rose et al., 1982).

## ORIGINAL SKILL ACQUISITION

There is general agreement that the amount of original training is positively related to the amount of retention. The higher the level of performance at the completion of training, the higher the performance on an initial retention test. Final performance level, then, provides an indication of relative retention rates (Gardlin and Sitterly, 1972; Schendel et al., 1978).

Thus, the training or learning phase can influence retention, and because the amount of training is positively related to retention, overtraining aids retention. Instead of training to a minimally proficient level, mastery or overtraining may be more cost effective in terms of increased retention (Schendel et al., 1978).<sup>1</sup>

There may be limits to the amount of overlearning required, both in terms of cost-benefit tradeoffs and impact on retention. One review of military experiments in this area suggested that much would depend on the level of proficiency required and the availability of time and/or resources for refresher training. For an easily acquired task, overtraining may not be a cost-effective solution. On the other hand, it may be a very cost-effective approach if refresher training is expensive. Moreover, at least one army experiment indicated that at some point overlearning of a task, i.e., increasing the number of learning trials, ceases to add much to retention of that task (Rose et al., 1982).

Because final performance level prior to the retention interval is an important indicator of retention, some attention has been paid to which training techniques enhance proficiency level and retention.

<sup>1</sup>Overtraining has the added benefit of making it more likely a skill is performed "automatically," i.e., without needing total attention to the process, an attribute which might aid performance in a combat environment (Schendel et al., 1978).

These include the spacing of practice sessions, test schedules, an environment that includes feedback cues and equipment fidelity, and well-structured tasks.

- *Massed vs. spaced practices*: There is some evidence that spacing repetitions of a task rather than massing the practices increases acquisition and retention (Schendel et al., 1978; Rose et al., 1981).
- *Test trials*: Research in verbal memory indicates that testing is part of the learning process. The addition of test trials results in quicker and more accurate learning, retention, and relearning (Schendel et al., 1978; Rose et al., 1981).
- *Supportive environment*: An important factor in promoting higher performance level in less time is the provision of accurate feedback of test results in quantity during training. Although the speed of learning does not affect retention, reducing the learning period may provide more time for overlearning, and therefore, higher retention. Equipment design can also affect performance level. The extent to which the display-control relationship mirrors expectations (e.g., moving the pointer to the right by moving the knob clockwise) affects skill acquisition and retention (Gardlin and Sitterly, 1972; Schendel et al., 1978). The similarity of training devices to operational equipment is also a factor.
- *Structure of task*: Tasks that are highly structured or logically organized are more quickly learned and, when moderately learned, retained longer than unstructured tasks (Schendel et al., 1978; Armstrong et al., 1975).

## RETENTION INTERVAL

If retention is related positively to the amount of training, it is related negatively to the retention interval: The longer the interval, the greater the skill loss. In fact, the beneficial effects of overlearning can be totally negated if the interval is too long (Gardlin and Sitterly, 1972).

The theory of interference provides an explanation for the positive and negative relationship of amount of training and length of retention interval to skill retention. The more training and practice, the stronger the memory traces, or habits, are in relationship to subsequent, competing learning. But, the longer the retention interval, the more likely there will be competing, interpolated learning (Adams, 1967).

The amount of skill decrement may be accelerated by the nature of the competing, subsequent learning. The learning of highly similar or dissimilar tasks during the retention interval does not appear to adversely affect the retained skill. However, newly acquired skills that are of moderate or intermediate similarity can increase decrement of the retained skill beyond normal expectations (Armstrong et al., 1975).

Some general statements can be made about the rate of skill loss, although retention curves are task specific, varying by type of skill and performance conditions and measures (Gardlin and Sitterly, 1972). Skill decay is most rapid during the initial retention period. This leads to the paradox that "the absolute amount of forgetting declines with time" (Schendel et al., 1978). This phenomenon makes it even more difficult to plot retention curves, especially if data are limited--only a few retention test scores (Rose et al., 1981). In measuring skill decay, the most sensitive indicators are commissive rather than ommissive errors (Gardlin and Sitterly, 1972).

Practice during the retention interval enhances skill retention (Gardlin and Sitterly, 1972; Armstrong et al., 1975; Schendel et al., 1978.). This applies to imaginary practice as well as recreations of the original test conditions. The closer the practice to those original conditions, the greater the benefits for retention. However, even mental practice has a positive impact on retention (Armstrong et al., 1975). Practice provides the greatest benefit to those skills which decay most rapidly--procedural tasks and temporal aspects of an acquired skill (Gardlin and Sitterly, 1972).

## SKILL RECALL AND REFRESHER TRAINING

Skills that have not been retained must be reinstated or refreshed. For any task, refresher training takes place much more rapidly than the original training. In addition, refresher training takes less time, the greater the original proficiency and experience, and more time, the greater the retention period or the more difficult the task (Gardlin and Sitterly, 1972).

Task characteristics affect retention and refresher training time. It takes longer to refresh procedural than continuous motor tasks to the previous acquisition levels (Gardlin and Sitterly, 1972). However, it is usually less expensive to refresh procedural tasks, which are often a matter of knowing the correct sequence of steps. Refresher courses may require little beyond verbal cues and pencil paper exercises. On the other hand, continuous motor tasks, which emphasize how the task is done, can require expensive, hands-on equipment or simulators (Schendel et al., 1978).

The following techniques appear to aid recall:

- *Warm-ups or rehearsals* can promote recall after a period of non-practice. However, because benefits vary by task and activity, it has been suggested that more research is needed to identify how best to utilize such methods (Gardlin and Sitterly, 1972; Schendel et al., 1978).
- *Cues learned during skill acquisition* help in later retention. Training techniques such as using mnemonic devices as a memory aid for verbal skills can be useful if the student is also taught to employ such strategies (Adams, 1961; Kose et al., 1982).
- *Fidelity of test environment* benefits retrieval, i.e., the closer the retention test resembles the original training environment, the greater the skill recall (Gardlin and Sitterly, 1972).

## INDIVIDUAL DIFFERENCES

Much of the literature hypothesizes that individual differences should affect retention, but so far researchers have been unable to identify and measure those differences. It may be that the analyses have been too simple, measuring only a single trait for a complex, multidimensional individual. Such problems would be compounded if it turns out that individuals have different retention capacities for different kinds of skills (Rose et al., 1982).

A major theoretical disagreement related to this issue is whether skill acquisition is affected by the changing nature of the task or the individual's ability. Two theories exist:

- *Changing task structure* argues that as learning of a complex skill continues, certain abilities which may be more important in the initial training become less important as the level of training progresses.
- *Changing subject model* argues that all the abilities remain important throughout training but that training can increase certain abilities, that the strength of an individual's relevant abilities changes.

Hulin and Alvares (1971) suggest that both theories explain the data and that both explanations play a role. It appears then that definitions of individual differences may well have a dynamic quality which complicates the number of factors that interact to affect skill acquisition and retention.

What is known about the relationships between individual differences and retention pertains to the period of skill acquisition. Individual differences contribute to the rate and level of skill acquisition. For example, there are faster and slower learners. And individual characteristics, such as IQ, can contribute to the level of skill acquisition. Because the final level of skill acquisition is important in retention, individual differences indirectly contribute to that retention. Individuals that achieve higher skill levels can have the same *rate* of proficiency loss as those at lower skill levels.



Because they started from a higher achievement level, they continue to test at a higher achievement level on retention tests, even if relative declines in proficiency tend to be similar (Schendel et al., 1978; Gardlin and Sitterly, 1972).

Vinegard (1975) illustrates the difficulty in identifying an individual characteristic that will distinguish skill performance across the board. His study on basic skills retention as a function of mental category revealed that during skill acquisition the highest mental category group tended to outachieve the others. When retention tests were performed this pattern held. However, in terms of individual measures there were overlaps between the groups in which some individuals in lower mental categories outscored some members of the highest group.

Given the current status of research, it would appear that level of skill attained in training is a better predictor of varying retention rates than individual differences, even though the latter may contribute to skill attainment.

## PERFORMANCE MEASURES

The literature contains a number of caveats concerning how accurately various measures of performance reflect skill attainment and retention.

First, specific measures may address only one aspect of a skill. Experimenters usually apply two measures to motor skills--speed and accuracy. Thus, typing tests count not only words per minute but also number of typos. The distinction is important for skill retention since some aspects of a skill may decay faster than others. For example, there is evidence that timeliness or temporal skill is the last element of a skill to be acquired and the first lost (Gardlin and Sitterly, 1972).

Second, both absolute and relative reference points are required to describe skill decrement. The former provides an indication of actual skill level, whereas the latter indicates the rate of skill decay (Gardlin and Sitterly, 1972).

A major problem arises when retention is measured by comparing multiple tests or performances. Any time there is an array of scores, consistency of response becomes an issue. Thus, in a test containing ten questions, a subject may get three answers right during two administrations of the test, but it may not be the same three answers. Likewise, five members of a platoon may pass a repeated skill test, but it may not be the same five members.<sup>2</sup> To measure consistency of response, some measure of variance or correlation, in addition to mean numbers, is required (Bilodeau, 1969; Gardlin and Sitterly, 1972).

### TASK TAXONOMIES

The development of taxonomies of task characteristics may be one tool for linking broader abilities and tasks to retention of specific skills. Edwin Fleishman has been a consistent advocate of using task taxonomies to predict human performance and retention of specific skills. In 1965 he reported that relatively few psychomotor abilities were needed to perform over 200 different skilled tasks. The research identified, defined, and measured the components of these abilities (e.g., multilimb coordination, manual dexterity, finger dexterity, and reaction time) (Fleishman, 1965).

Fleishman recently participated in a review of the literature on task taxonomies and concluded that such classifications are formulated on four basic approaches (Fleishman, 1982).

1. Behavior descriptions--classifications of observed behavior in performing a task (e.g., setting dials and reading meters).
2. Behavior requirements--classifications of inferred behavior in performing a task (i.e., the process which occurs between the input and the response). Includes such categories as scanning, identification, and problem solving.

<sup>2</sup>The Vineberg study of retention of basic soldiering skills again provides an example. Some 8.1 percent of all the subtests were failed during baseline training, but passed during retention testing. "From a logical viewpoint, this percentage is an inconsistency and can be viewed as 'error' because, strictly speaking, a soldier cannot demonstrate the retention of skill that he has previously failed to show he has acquired" (p. 12).

3. Ability requirements--classifications of underlying abilities or traits necessary to various tasks. Fleishman's earlier study cited above is an example.
4. Task characteristics--descriptions of task conditions or components (e.g., type of display). While the other three emphasize the individual's behavior and ability, this approach addresses the task itself as a separate entity.

Wheaton and Mirabella (1972) applied the last approach to the design of sonar training systems. They identified and quantified specific features necessary to a sonar training device, and then applied those measurements to distinguish among existing devices concerning particular trainee tasks. To achieve that they first had to identify and index the subtasks. This resulted in 17 indices or device descriptors, such as number of responses comprising the procedural sequence, number of different controls manipulated, and percentage of alternative actions in an operation.

Fleishman warns that the major problem with the task characteristics approach is that it is sensitive to the selection of components described, i.e., relevant stimuli, instructions, procedures, responses, and goals. He, therefore, stresses the need to evaluate task classification systems for internal and external reliability, and urges the construction of objective, quantifiable descriptors (Fleishman, 1982).

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